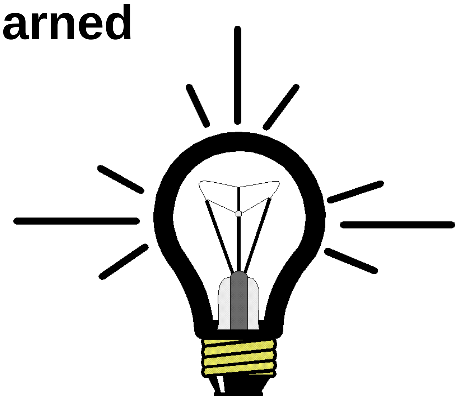
Section 1

Cost-Estimating Concepts/ Lessons Learned



1

Section 1 of this material will form the basis for the workshop.

Notes / Discussion Points / Lessons Learned: ______________________________

Protocol Reminder

- **The ACE Team will document lessons learned and innovative ideas identified in the workshop.**
- **Ideas will be evaluated for complex-wide applicability.**
- **Ideas with broad applicability will be disseminated across the complex.**

2

***Discussion Leader/Facilitator Notes:** As discussed in the Introduction, we encourage active participation. The Notes/Discussion Points/Lessons-Learned lines provided at the bottom of each page are for participants to record ideas or lessons learned.*

Reminders:

- A designated ACE Team member will be responsible for documenting lessons learned and innovative ideas that was identified and recorded by the note taker during the workshop.
- The ACE Team (as a whole or through chartered subteams) will evaluate ideas and lessons learned for complex-wide applicability, ease of implementation, etc.
- Noncontroversial lessons and ideas will be disseminated across the complex immediately. The others will be further analyzed, and field and headquarters management will be briefed to reach a consensus regarding which idea(s) or lessons learned should be pursued.
- The Notes/Discussion Points/Lessons-Learned lines are at the bottom of each page for participants to record ideas or lessons learned.

Notes / Discussion Points / Lessons Learned: ____________________

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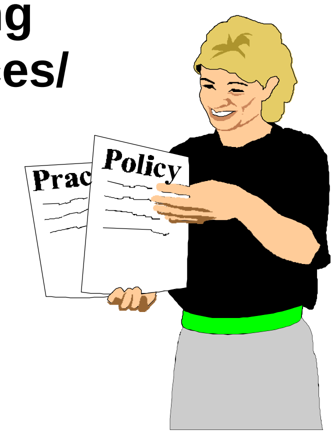
Section 1.1

DOE Cost-Estimating Guidance and Practices/ Lessons Learned



1

This section discusses DOE guidances and practices for cost estimating.

Notes / Discussion Points / Lessons Learned: ____________________

DOE Cost-Estimating Guidance and Practices

- **Cost estimates will be developed and maintained throughout the life of each program and project.**
- **Estimate changes will be reconciled and traceable to previous estimates and the baseline.**
- **Cost estimates will be updated periodically.**

2

- EM guidances on cost estimation and analysis emphasize existing DOE-wide guidances and sound cost-management principles as they apply to all EM activities.

- EM managers are responsible for determining case by case the extent to which the guidance statement will be effected. The following laws, DOE Order, guidances, and practices govern cost-estimating requirements:
  - Integrated Planning, Accountability, and Budgeting System (IPABS) Handbook
  - DOE Order 430.1, *Life-Cycle Asset Management*
  - DOE Good Practice Guide, GPG-FM-032 Life-Cycle Cost
  - DOE G 430.1-1, *Cost Estimating Guide*
  - Cost Quality Management Assessment Handbooks, Volume 1
  - Davis-Bacon Act
  - Service Contract Act
  - National Environmental Policy Act of 1969 (NEPA)
  - Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
  - Resource Conservation and Recovery Act (RCRA)
  - Superfund Amendments and Reauthorization Act of 1986

Notes / Discussion Points / Lessons Learned: ____________________

Integrated Planning, Accountability, and Budgeting System

- **Three Primary Subsets of IPABS**
  - **Planning**
  - **Budgeting**
  - **Performing**

- **Cost estimates are a key part of the project planning, budgeting, and performing processes**

3

- The Integrated Planning, Accountability, and Budgeting System (IPABS) restructures and streamlines formerly independent pieces of the Environmental Management Program's current management structure into one cohesive system.

- IPABS comprises three primary subsets of activity:
  - Planning
  - Budgeting
  - Performing

- IPABS elements are:
  - Accomplishing the 2006 Plan
  - Data validation
  - Annual budgets
  - Management commitments
  - Metrics
  - Management tracking
  - Projectizing

- Cost estimates are a key part of the project planning, budgeting, and performing processes.

Notes / Discussion Points / Lessons Learned: ______________________________

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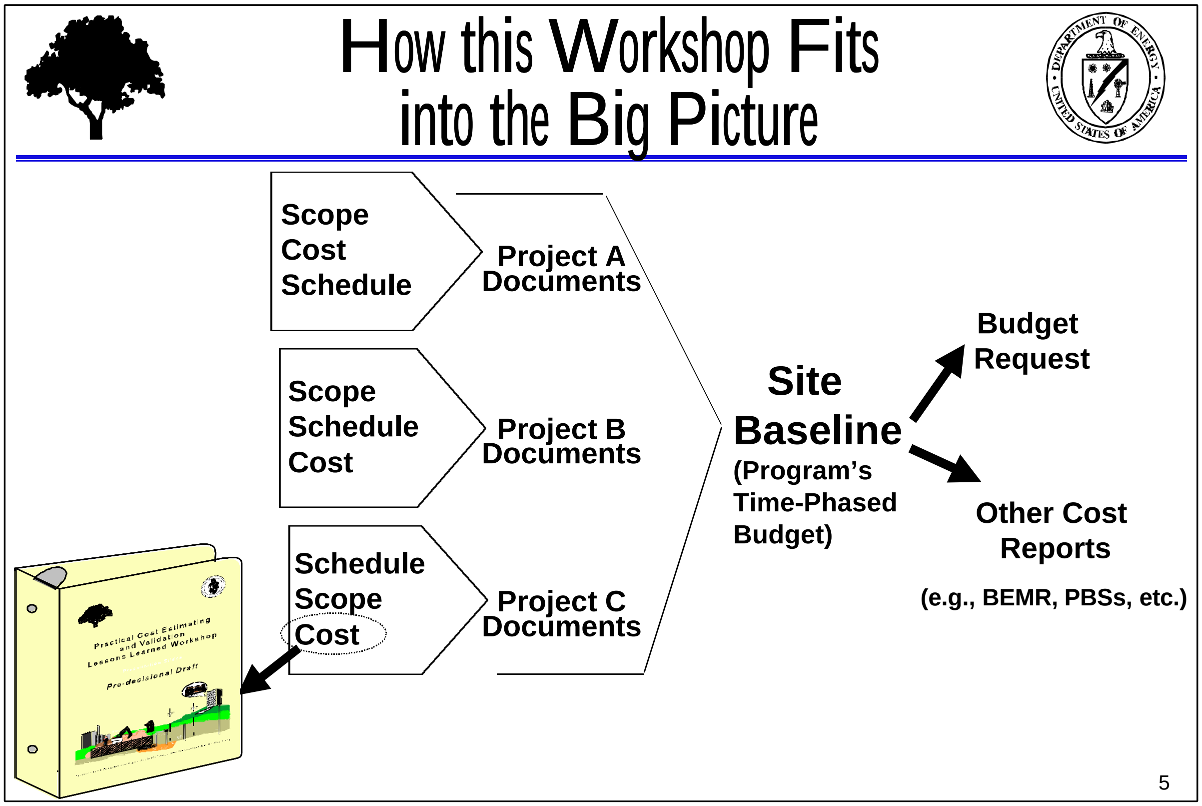
The 2006 Plan Vision

- **The 2006 Plan vision is accomplished by:**
  - **Projectizing**
  - **Shifting responsibility and accountability to the field**
  - **Changing HQ Program Managers' responsibilities**
  - **Focusing on the desired end state**
  - **Applying a systems engineering approach**
  - **Streamlining financial management**
  - **Providing clear, consistent guidance and strategy information**
  - **Using collaborative decision making**

4

- IPABS accomplishes the 2006 Plan vision through a series of fundamental changes woven throughout the process.
  - Projectizing (identifying an individual or group of similar and/or associated activities that have a defined scope, schedule, and cost and that support a defined end-state)
  - Shifting the majority of management responsibility and accountability to the field
  - Shifting the responsibility of HQ Program Managers from involvement in detailed project management to planning, guidance coordination, and analyses of cross-cutting site issues
  - Widening the focus from traditional narrow project status to desired end state and other outcomes
  - Applying a systems engineering approach to optimizing projects
  - Streamlining financial management
  - Acknowledging the importance of clear, consistent guidance and strategy regarding information and information technology within EM
  - Using collaborative decision making

Notes / Discussion Points / Lessons Learned: ____________________

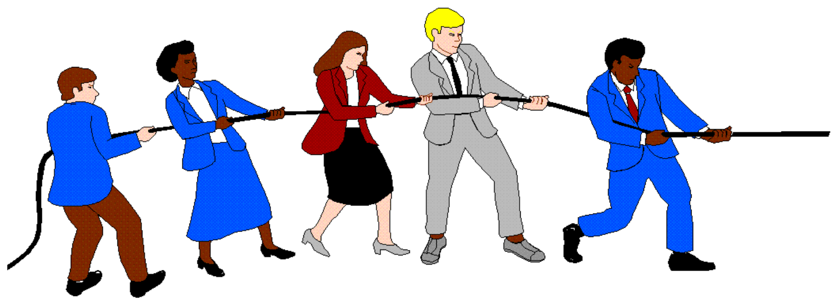


- The project scope, cost estimate, and schedule form the basis for each project's documentation.
- The roll-up of the project documents creates the program's time-phased budget.
- The baseline is used to back up the budget request, as well as any other cost reports.
- This workshop focuses on developing of the project cost estimate.

Notes / Discussion Points / Lessons Learned: ____________________

Section 1.2

Project Team/ Lessons Learned

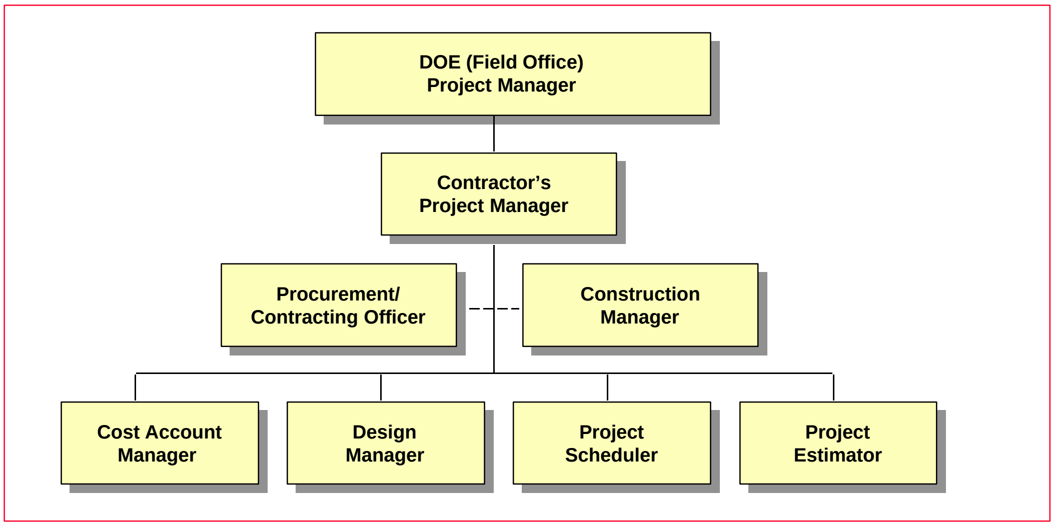


1

The project team is responsible for the development and accuracy of the project cost estimate. The cost-estimate team is the entire project team or a subset of the project team.

Notes / Discussion Points / Lessons Learned: ____

Components of the Project/Estimating Team



2

- The team may consist of not less than the following people:
  - DOE Project Manager
  - Contractor's Project Manager
  - Cost Account Manager
  - Design Manager
  - Project Scheduler
  - Project Estimator

- Additional project team personnel required as applicable to specific efforts might include the following:
  - Remediation Scientist
  - Remediation Engineer
  - Construction Manager
  - Procurement/Contract Manager
  - Quality Assurance/Quality Control Manager
  - Project Control Manager
  - Human Resources (staffing)
  - Other staff members as required
  - Applicable technical resources

- The cost-estimating responsibilities of each project/estimating team member are given on the following pages.

Notes / Discussion Points / Lessons Learned: ______________________________

DOE's Responsibility to the Project Team

DOE HQ Program Manager

- Set national strategy
- Issue policy and guidance
- Establish and monitor project performance metrics
- Act as demanding customer of field organization
- Serve as program's informed advocate
- Identify cross-site opportunities

DOE Field Office Project Manager

- Execute project
- Monitor project
- Conduct performance assessments
- Project cost for budget and planning purposes
- Keep HQ informed

3

- IPABS shifts the responsibility of HQ Program Managers from involvement in detailed project management to planning, guidance coordination, and analysis of cross-cutting site issues.

- HQ programs need to be involved more at the "front-end" of the project and less at the "back-end."

- Operations/Field Offices are responsible for all phases of program execution, including project monitoring, Project Officer performance assessments, projecting costs for budget and planning purposes, and keeping HQ informed.

- The HQ role is to set national strategy, issue policy and guidance, establish and monitor program performance metrics, act as a demanding customer of field organizations, and serve as the program's informed advocate with Congress and stakeholders at the national level.

- HQ will need to be able to identify cross-site opportunities to achieve the ten-year vision. To facilitate this shift in responsibility, HQ will need program managers who have a general understanding of site issues and program-wide interfaces.

Notes / Discussion Points / Lessons Learned: ______________________________

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Cost-Estimating Team

4

- The cost-estimating team is the entire project team or a subset of the project team.
- The cost-estimating team consists of a group of professionals who are technically competent in their respective fields. The type of project will determine the team makeup and the necessary technical expertise.
- The team is collectively responsible for achieving the goals and objectives of a program or project.
- The estimator normally organizes and prepares the estimate for the project team.
- To have a quality estimate requires that the entire team be participants in the development of the estimate.
- Each team member is responsible for sharing relevant project information needed to develop the cost estimate.
- Team members may serve in more than one role on the team. For example, the project manager may also be the cost account manager.

Notes / Discussion Points / Lessons Learned: ______________________________

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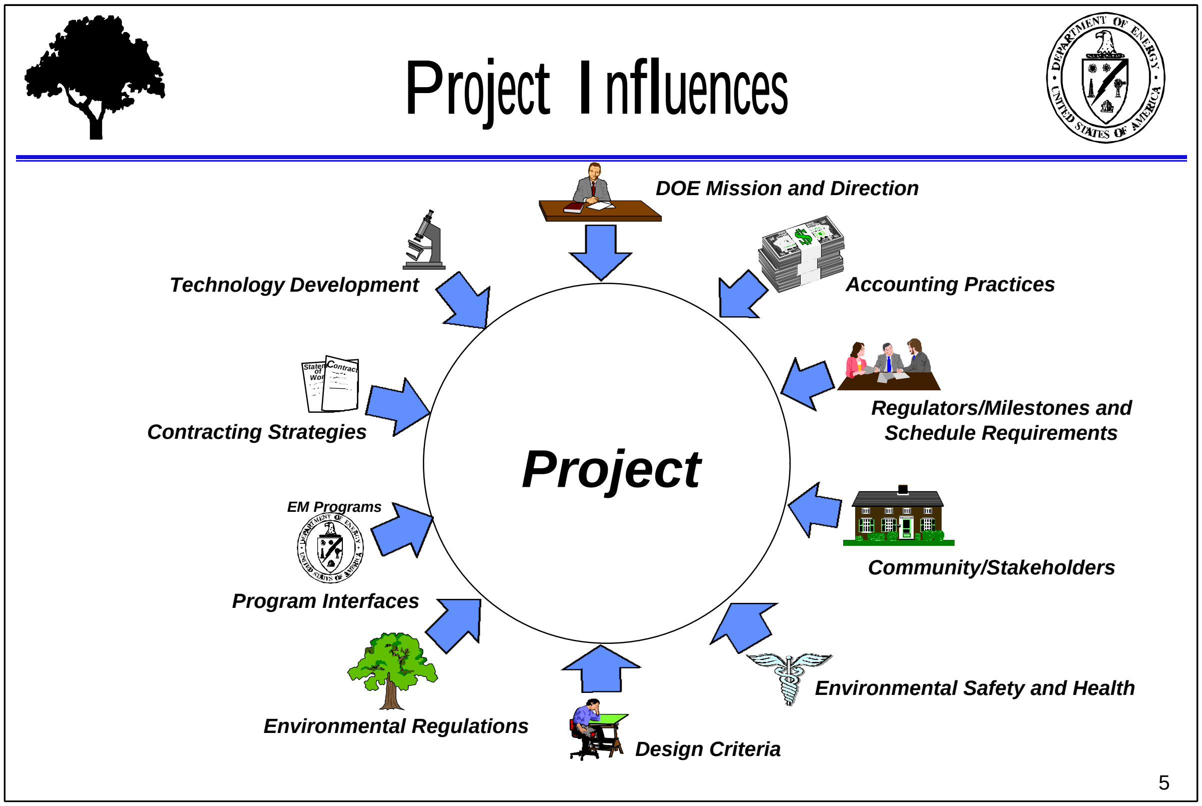

Project Managers/Project Teams must acknowledge and plan for the many internal/external influences that may affect a project's baseline.

These influences include, but are not limited to, the following items:

- DOE mission and direction
- Departmental accounting practices (i.e., impact of changing G&A rates, color of money, etc.)
- Regulator requirements (e.g., milestones, agreements, etc.)
- Community and stakeholder concerns
- Environmental safety and health requirements
- Design criteria (e.g., DOE orders, EPA requirements, etc.)
- Environmental regulations (CERCLA, RCRA, NEPA, etc.)
- Program interfaces and interdependencies
- Contracting strategies/restructions
- Technology development (effects of new technologies or the lack of a feasible technology to solve remedial actions)

Notes / Discussion Points / Lessons Learned: ______________________________

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Cost-Estimating Responsibilities of the Team Members

<u>Team Leader</u>

DOE Field Office Project Manager

6

The DOE Field Office Project Manager's cost-estimating responsibilities include the following:

- The ultimate responsibility for the project lies with the project manager/team leader.
- Ensuring that the appropriate team members are involved as needed in developing the cost estimate.
- Ensuring the proper execution and completion of the cost estimate.
- Ensuring the appropriateness and accuracy of the cost estimate.
- Ensuring that the cost estimate is defensible.
- Ensuring that the cost estimate is maintained and updated as project-scope information is revised and refined.
- Ensuring that the cost estimate reflects the project plan.
- Ensuring that the project cost estimate is validated.
- Keeping Headquarters informed.

Notes / Discussion Points / Lessons Learned: ______________________________

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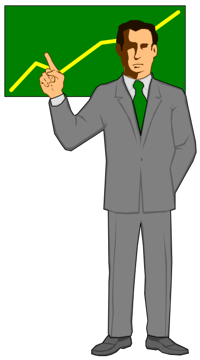
Cost-Estimating Responsibilities of the Team Members



Contractor's Project Manager

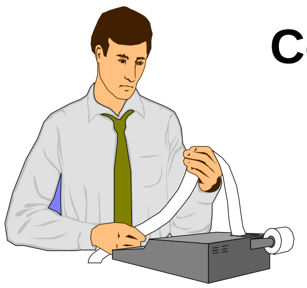
7

The Contractor's Project Manager's cost-estimate responsibilities include the following:

- Providing qualified resources for development of all aspects of the cost estimate.
- Ensuring that a project cost estimate is developed.
- Ensuring the completeness and accuracy of the estimate.
- Developing the project plan and ensuring that the estimate reflects that plan.
- Ensuring that the cost estimate is updated and maintained current.
- Defending the cost estimate.
- Ensuring that the appropriate risk assessment has been conducted to identify potential situations that will have a significant impact on overall project cost and schedule.
- The project manager is to develop the major activities (components/building blocks) of the project and the WBS to be used for the project.
- The project manager must document the assumptions that influence scope, schedule, and cost.

Notes / Discussion Points / Lessons Learned: ______________________________

Cost-Estimating Responsibilities of the Team Members



Control (Cost) Account Manager

8

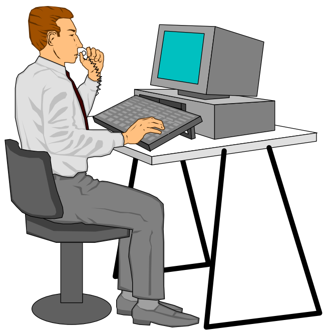
Discussion Leader/Facilitator Notes: The Control (Cost) Account Manager (CAM) must be designated before or at the same time as the initiation of the request for the estimate.

The CAM's cost-estimate responsibilities include the following:

- Identifying all work activities to be performed by contractors, subcontractors, or internal forces under control of the CAM.
- Auditing the detailed methodology used in the project estimate to ensure adherence with applicable guidelines.
- Ensuring that the estimate meets the reporting requirements of the project control system.

Notes / Discussion Points / Lessons Learned: ______________________________

Cost-Estimating Responsibilities of the Team Members



Design Manager

9

The Design Manager cost-estimate responsibilities include the following:

- Ensuring that all drawings, specifications, and other relevant documentation applicable to the technical direction of the project are formally transmitted to the estimator.
- Ensuring that a written cover letter listing transmitted documents is included with the documents.
- Ensuring that transmitted documents are the latest versions.
- Providing the estimator with timely responses to queries.
- Defining drawings or sketches and limitations of the contractor or subcontract scope of work as identified by the CAM.

Notes / Discussion Points / Lessons Learned: ______________________________

Cost-Estimating Responsibilities of the Team Members

Project Scheduler

10

The Project Scheduler is responsible for the following tasks:

- Working closely with the project estimator to ensure that the schedule and the estimate are appropriately integrated.
- Providing the Project Estimator a schedule that demonstrates the critical path consistent with the latest official technical scope.
- Identifying sequentially required activities that may affect the project cost estimate.

Notes / Discussion Points / Lessons Learned: ______________________________

Cost-Estimating Responsibilities of the Team Members

Project Estimator

11

The Project Estimator is responsible for the following tasks:

- Developing, reviewing, reconciling, and presenting the project estimate.
- Developing quantity from the project source documents (scope of work, drawings, sketches, specifications, etc.).
- Ensuring that historical cost data are used where appropriate.
- Identifying the price sources and labor-adjustment factors that were used in the estimate.
- Maintaining the complete project estimate documentation file.
- Identifying types of resources, crew size, and mix for resource loading into the schedule (with assistance from the team).
- Present the cost estimate in current year dollars, net present dollars, escalated dollars, contingency, etc., as requested.

Notes / Discussion Points / Lessons Learned: ______________________________

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Cost-Estimating Responsibilities of the Team Members

Team Reviews and Responsibility Sign-off

12

- The project cost-estimating team is responsible for reviewing all estimating documents produced.
- The estimator is responsible for distributing copies of the estimate documents to the team for review.
- The project team review must provide a detailed review of all Statements of Work and elements of cost contained in the estimate and supporting documentation.
- All team members must be identified and must indicate their respective areas of responsibility in the preparation of the cost estimate.
- Sign-off responsibilities vary from site to site and organization to organization.

Notes / Discussion Points / Lessons Learned: ______

13

Be careful to ensure that management is part of your team!

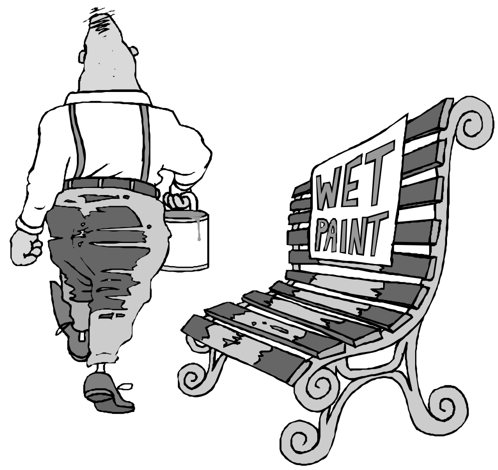
- The project manager is responsible for keeping management informed about the project.
- The project manager is responsible for ensuring that the project scope is clearly defined.

Notes / Discussion Points / Lessons Learned:

Lessons Learned

Team

- **Roles**
- **Work Efficiency**



14

Discussion Leader/Facilitator Notes: The facilitator is to encourage discussion and lessons learned related to cost-estimate team roles and responsibilities.

Roles

1. Does everyone agree with the team and players and their various roles as defined?

2. Have any breakdowns in communication or action occurred because people either didn't perform their roles or tried to do someone else's role?

3. What was done to correct the situation?

4. Does a better organization or definition of the roles exist to ensure better work efficiency? [For example, would written roles provided by the project manager at the start of the project (or a change in a person's assignment) be more effective?]

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________________

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Work Efficiency

5. In addressing the roles of each team player, what could be done to improve the efficiency of the effectiveness of the overall team? (For example, are there too many project meetings or not enough?)

6. Do data necessary for your work get lost for days, or do these get to you quickly?

7. Do things shut down when team members go on vacation or have other special assignments to which they must attend?

8. Do you have all the data and tools you need to do the job?

9. How much do you think you are overmanaged or second-guessed by the project manager? How did you respond? What can be done to prevent or alleviate this?

10. How active are the stakeholders in the cost estimating process? How much should they be included? How should this issue be addressed?

Notes / Discussion Points / Lessons Learned: ______________________________

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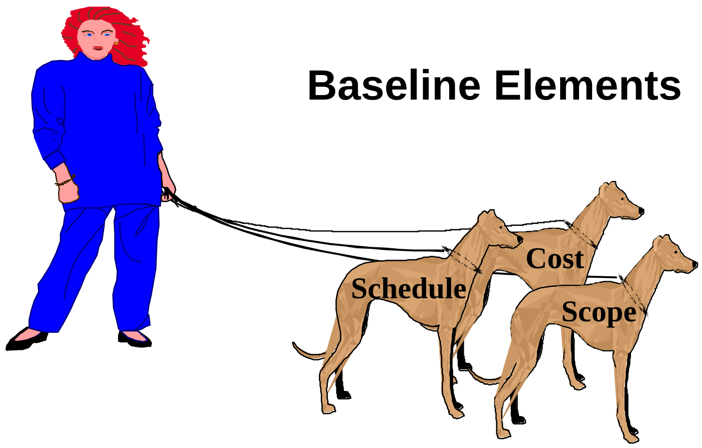
Section 1.3

Baseline Elements



1

Discussion Leader/Facilitator Notes: Have a discussion about which dog is in the front.

“Project baselines define the scope of work to be accomplished, the associated schedule of events, and the estimated cost associated with doing the work for a project’s life-cycle” (IPABS).

This section will discuss cost estimates as an integral part of the project baseline development.

Notes / Discussion Points / Lessons Learned: ______________________________

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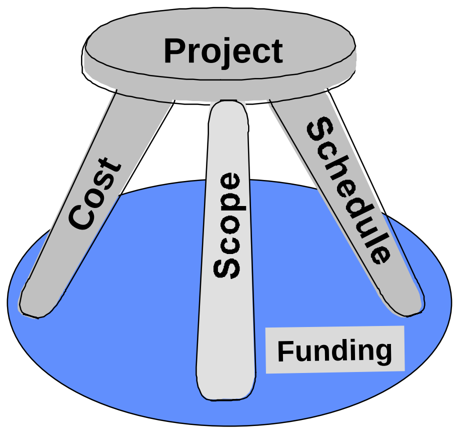
Baseline

Relationship of Technical Scope, Cost Estimate, and Schedule Baseline

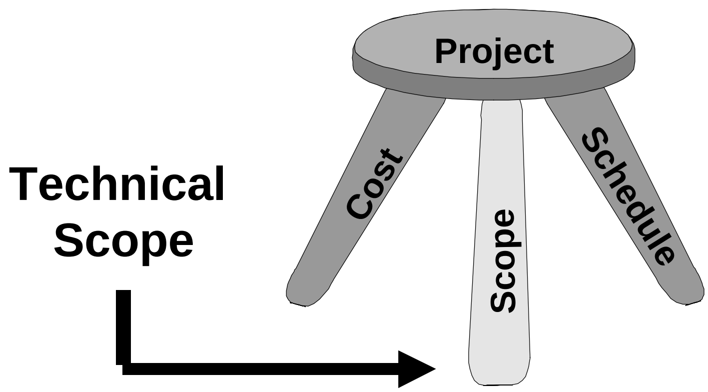


2

- Changes to any assumptions in the legs of the stool will affect the project's position.
- Changes in project funding may affect all three project elements: scope, schedule, and cost.
- The technical scope forms the primary basis and foundation for the development of the cost estimate and the project schedule.
- As technical scope moves from the conceptual level toward the definitive level, the cost estimate, and the schedule will also become more refined.
- Baseline should establish the basis for the budget request.
- Baseline provides the basis for performance measurement of the project.
- Baseline provides the basis for all change control.

Notes / Discussion Points / Lessons Learned: ______________________________

Technical Scope



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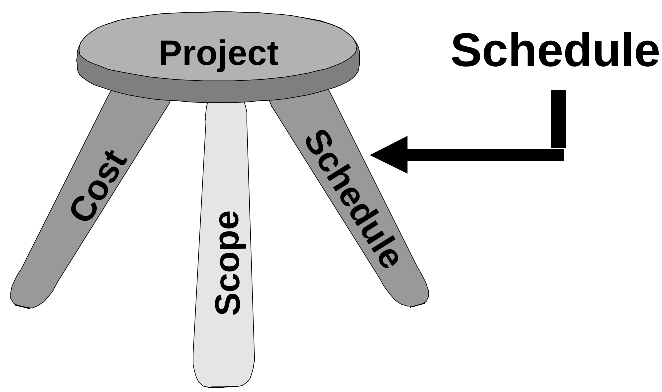
Discussion Leader/Facilitator Notes: Elements in the first bullet could involve discussion of innovative technology, risk, etc.

- The technical scope should include all requirements for the project or program. It should, at a minimum, include the following information:
  - Detailed description of work to be performed
  - Description of regulatory drivers
  - Deliverables
  - Any constraints or special conditions
  - Sequence of events and any interdependencies
  - Milestones
  - Work Breakdown Structure (WBS)
  - Cost Structure/Code of accounts (e.g., HTRW)
- The Program/Project Manager should provide the preceding items to the estimator, or the estimator may assist in their development.

Notes / Discussion Points / Lessons Learned:

Schedule



4

- The schedule is used as the basis for both the budget cycle timing and the escalation of project costs.
- The schedule used or developed with the cost estimate should be documented and becomes part of the cost-estimation package.
- Milestones, dependencies, and the critical path are identified in the schedule.
- The schedule should be resource loaded.
- Resource-loaded schedules should be leveled according to labor hour or dollar requirements.
- All schedule assumptions must be defined and traceable in the schedule.

Notes / Discussion Points / Lessons Learned: ______________________________

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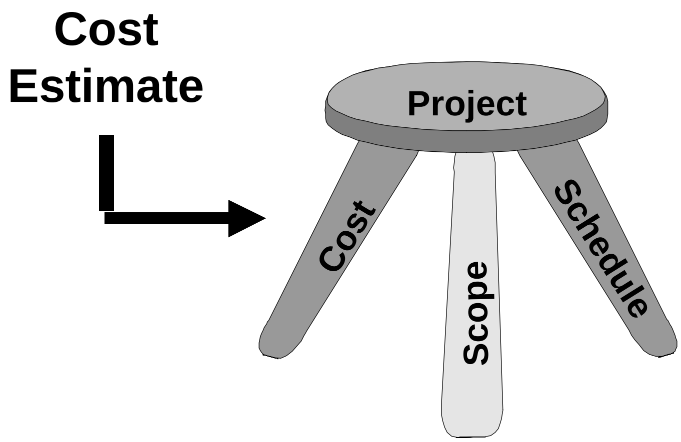
Cost Estimate



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- After the technical scope information is available, the estimator can start developing the cost estimate. The estimate forms the basis for defining and controlling the project cost.
- As the estimate is developed, the estimator should keep well-organized worksheets and documentation, including the following:
  - Definition of what is included and specifically excluded in the total cost of the project.
  - Methodology of how the estimate was developed, including information such as any cost data bases used, actual quotes used, etc.
  - Description of direct and indirect costs. Field-distributable overhead should be in enough detail to describe what is included (e.g., site security, on-site trailers, health, and safety).
  - Explanation of site overhead rates.
  - Definition of when startup begins and ends along with the associated costs for those activities.
  - Operating costs if the estimate is a program estimate and includes operations as well as construction activities.
  - Allowance for escalation (based on the latest approved schedule) and identification of base-year dollars.
  - Contingency allowance and associated contingency/risk analysis.
  - Estimate assumptions and bases.
  - Costs should be estimated in conformance with the cost structure/code of accounts (e.g., HTRW).

Notes / Discussion Points / Lessons Learned: ____________________

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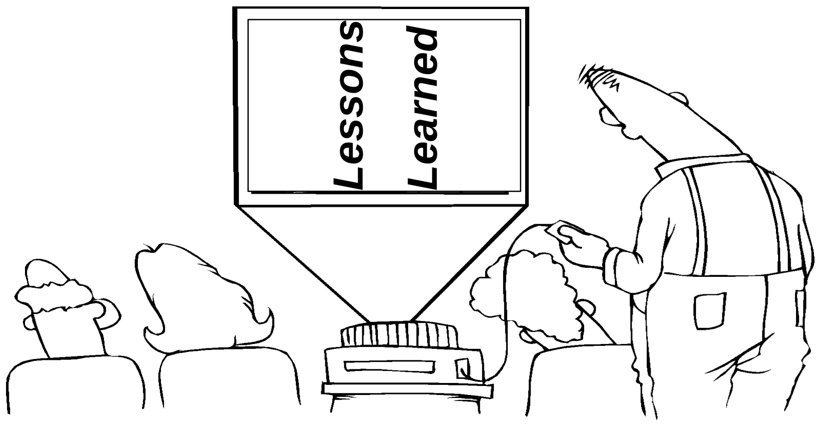
Section 1.3: Baseline Elements/Lessons Learned

Lessons Learned



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1. Technical Scope: How do you ensure that you have the best defined scope possible before doing an estimate?

   What are some of the techniques or questions you use to do this?

   How do you document it accurately?

2. Of the following technical scope items, which are the toughest to define and what is your technique to best do that: scope description, deliverables driver, constraints, sequence of events, dependencies, and milestones

   Are there ways the system could help this work better?

3. In the generation of the schedule for a project, what problems occur between the scheduler and the cost estimator that might be alleviated?

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

Section 1.3: Baseline Elements/Lessons Learned

Do you always receive the detail data you need?

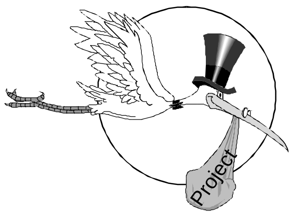
Does the scheduler have any consideration for your support to him?

Could the working relationship be improved?

If so, what would you suggest? How is the estimate affected by any of this?

Notes / Discussion Points / Lessons Learned:

Section 1.4



Life Cycle of Environmental Restoration Projects/ Lessons Learned

1

The Life-Cycle Cost Good Practice Guide, GPG-FM-032, defines life-cycle cost as the sum total of all direct, indirect, recurring, nonrecurring, and other related costs incurred or estimated to be incurred in the design, development, production, operation, maintenance, and support of an asset throughout its expected useful life span and through final disposition. Operating revenues such as user fees, salvage receipts, or power revenues should be included as an offset to cost, if they are incidental to the project's mission (e.g., a production reactor might incidentally produce and sell electric power).

Refurbishment and restoration costs should be included in a life-cycle cost estimate if existing sites or facilities are used.

This section will describe the life cycle of Environmental Restoration Projects, life-cycle estimating, and how the two topics relate.

Notes / Discussion Points / Lessons Learned: ______________________________

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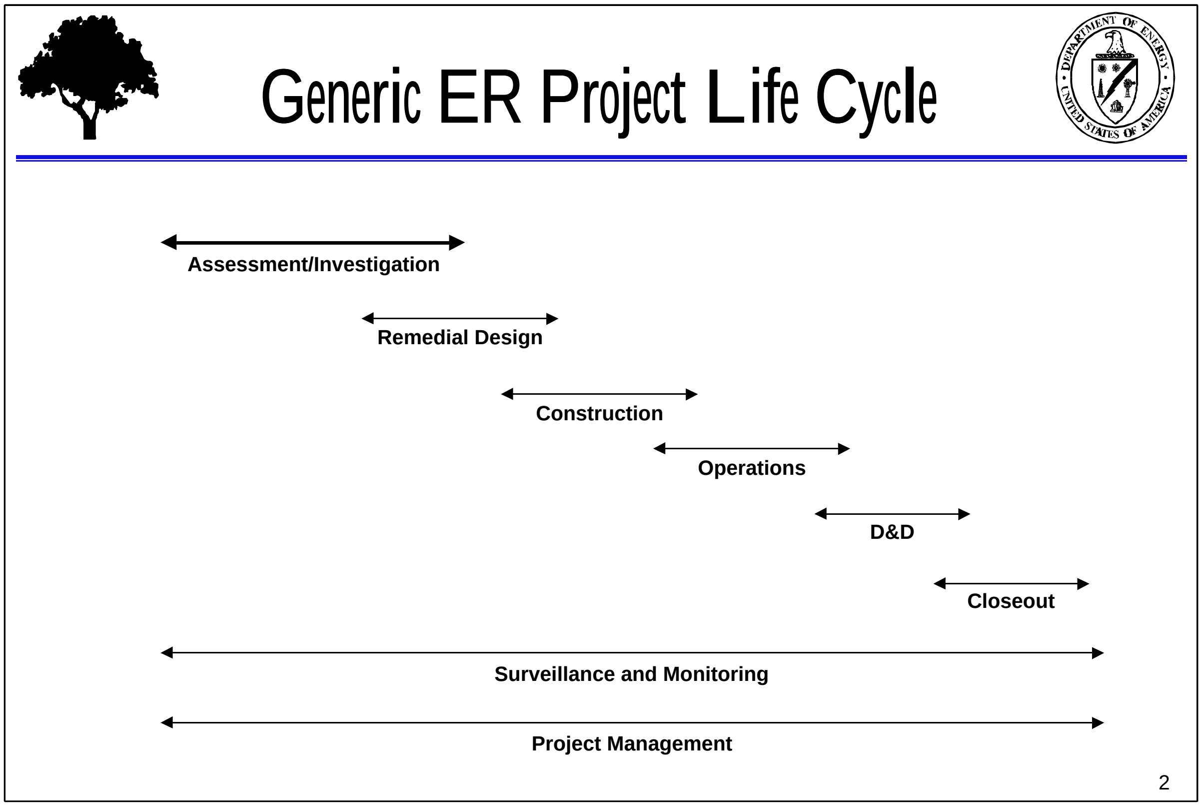
Section 1.4: Life Cycle of Environmental Restoration Projects/Lessons Learned



The diagram portrays the ER Project Life Cycle and relates it to critical decisions, DOE project phases, ER phases, and key ER deliverables.

- These are the general phases of the project life cycle. Not all projects will have all of these phases.

- Generic life cycle is applicable to both CERCLA-based and RCRA-based work. RCRA terminology is a little different than the CERCLA terms used in the slide. Comparison of CERCLA and RCRA phases are shown on Page 7.

Notes / Discussion Points / Lessons Learned: ______________________

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Project Life-Cycle Cost Estimating

- **Development of cost estimates overlaps project life-cycle planning**
- **Cost estimates become more detailed as projects progress**

3

Discussion Leader/Facilitator Notes: Refer to the life-cycle chart when discussing this slide.

- As a DOE project manager, you will likely see more than one cost estimate and schedule for any particular project you manage because the development and analysis of cost estimates and schedules is iterative. Estimates and schedules are revised or refined as more information becomes available or as internal and/or external forces (e.g., availability of funds) warrant.

- Every project — regardless of its stage in the project life cycle — will have some sort of cost estimate attached. Even the inception of projects will likely have some rough, order-of-magnitude-type estimate (e.g., the project will cost $5 million and, assuming that it begins in fiscal year 1996, will take 2 years to complete).

Notes / Discussion Points / Lessons Learned: ______________________________

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Project Life-Cycle Cost Estimating

- **Cost estimates reflect the total direct and indirect, recurring and nonrecurring costs**
- **They may address one or more of the major phases of a project**
- **They encompass all costs over the expected life span of the project**
- **They are iterative in nature**

4

Discussion Leader/Facilitator Notes: An example of a Life-Cycle Dictionary is provided in Appendix B.

- Life-cycle cost estimates evaluate the total direct and indirect, recurring and nonrecurring costs.
- Life-cycle estimates encompass all project costs (i.e., a CERCLA/RCRA project would include remedial design, construction, operation, deactivation and disposition, close out, surveillance and monitoring, and project management **over the expected life span of the project**, including postclosure and verification activities).
- DOE project managers are required to develop a life-cycle cost estimate at the outset of all projects.
- A life-cycle project cost estimate is required for every future work scope at each point where a critical decision/scope change will affect life-cycle cost.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

- Current working estimates reflect the following:
  - The latest cost and design data available,
  - Estimated costs to complete, and
  - Allowance for contingency based on current detailed risk analysis.
- Revised estimates are incorporated into the cost baseline through prescribed change control procedures.

Notes / Discussion Points / Lessons Learned:

Project Life-Cycle Cost Estimating

Why is Life-Cycle Cost-Estimating Important?

- **It forecasts future project costs**
- **It forecasts future resource needs**
- **It influences decision-making**
- **It supports strategic planning/budgeting**
- **It is comprehensive**

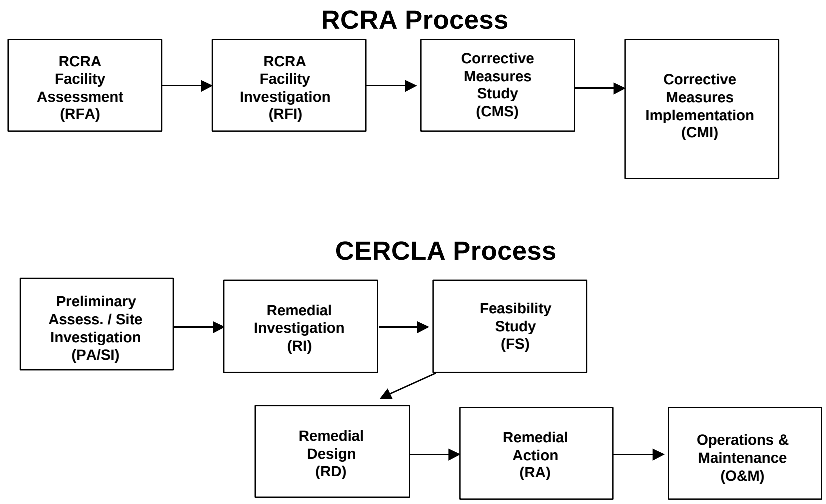
6

- Limitations of life-cycle costing include the following:
  - The degree of accuracy has a broad range early in the life of a project.
  - The high cost to perform the life-cycle cost analysis may make use of this estimating approach inappropriate for some projects.
  - It is highly sensitive to changing requirements.

- Common errors of project life-cycle costing include the following:
  - Omission of data
  - Lack of a systematic structure or analysis
  - Misinterpretation of data
  - Faulty or misused estimating techniques
  - A concentration on wrong or insignificant facts
  - Failure to assess uncertainty
  - Failure to check work
  - Estimating the wrong items
  - Using incorrect or inconsistent escalation data

Notes / Discussion Points / Lessons Learned: ______________________________

Estimating for CERCLA and RCRA Applications



7

- Environmental Restoration estimates should be developed using a structure that compliments the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA) program phase divisions.

- The use of a standardized Hazardous, Toxic, and Radiological Waste (HTRW) Work Breakdown Structure (WBS) compliments the required phases of remediation activities and enhances the consistency of estimate development across the complex.

Notes / Discussion Points / Lessons Learned: ______________________________

Estimating Assessment Phase

CERCLA Assessment Process

Preliminary Assessment (PA) → Site Investigation (SI) → Remedial Investigation (RI)

8

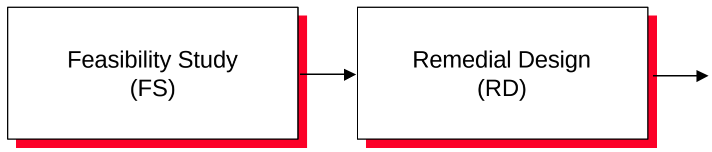
Discussion Leader/Facilitator Notes: Estimate types such as order-of-magnitude or planning estimates are developed with limited project scope definition. A preliminary estimate is developed using preliminary scope information. A definitive or detailed estimate is prepared using well-defined scope information. (See Section 1.5, Types of Cost Estimates).

- During the preliminary assessment phase, information is gathered on the types and amount of contamination expected at a project site.
- The life-cycle project estimate in this phase of the project will usually be a planning/order-of-magnitude estimate (see Section 1.5, Types of Cost Estimates) based on assumed future scope/schedule. A planning estimate is completed with limited project scope definition and assists in the preliminary evaluation and planning of the project. The basis for the planning estimate is very limited because a large amount of information is unknown and/or highly uncertain.
- A more detailed (definitive) estimate for the assessment phase can be completed after some basic information is available from a preliminary assessment or site inspection. This information may also provide better definition for total project costs. However, even though a detailed estimate may be prepared for the assessment phase, the entire project life-cycle estimate will probably remain planning/order-of-magnitude or possibly preliminary (see Section 1.5, Types of Cost Estimates).

Notes / Discussion Points / Lessons Learned:

Estimating Feasibility and Design

CERCLA Feasibility and Design Process



9

- The feasibility study requires that evaluation of cost be considered in analysis and selection of remediation alternates. Feasibility estimates are prepared on each proposed remediation alternative. By EPA guidance, the CERCLA Feasibility Study estimates shall have an accuracy of at least +50% to -30%. This is an order-of-magnitude estimate. These estimates perform two functions: (1) they present a total project life-cycle cost for each alternative being considered, and (2) they provide a logical, traceable framework for comparing alternatives.

- After a remediation alternative is selected and the project moves into the design phase, life-cycle estimates are usually prepared throughout the design phases as part of the 30%, 60%, and 90% design packages.

- At the end of remedial design, a detailed estimate is prepared for remediation and all other subsequent/concurrent project phase. This may be the government estimate if the work is subcontracted. If the work is not subcontracted, the estimate shall be of sufficient detail that it can be used as the project control tool for performance measurement.

Notes / Discussion Points / Lessons Learned: ______________________________

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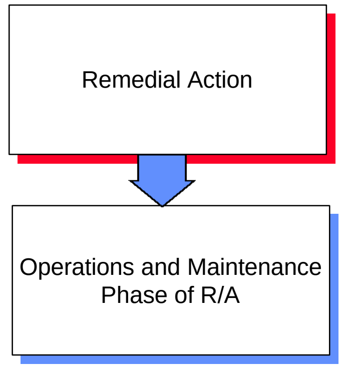
Estimating Remediation and Operations Phases

CERCLA Remediation and Operation Process



10

- The Remediation Phase of the project includes the final detailed design of selected remediation technology. This phase includes writing the Site Safety Health Plan, obtaining all site/work permits, and all other activities necessary to begin construction.
- Mobilization of construction crews, construction equipment, engineered equipment, and the physical construction of the plant necessary to support selected remediation activities are also included in the remediation phase.
- At this phase of the project, estimates are detailed and baselined and used to monitor and control execution of the remediation.
- Remediation also includes all start-up activities to ensure that constructed facilities are functional and acceptable for operation and maintenance.
- The Operations and Maintenance Phase of R/A includes the materials and labor necessary to operate the Environmental Restoration remediation systems. This phase includes facility operations, preventative maintenance, and maintenance not requiring a cost project to implement.
- Operations also includes any routine and nonroutine maintenance activities and process enhancements that cost project to implement and complete.

Notes / Discussion Points / Lessons Learned: ______________________________

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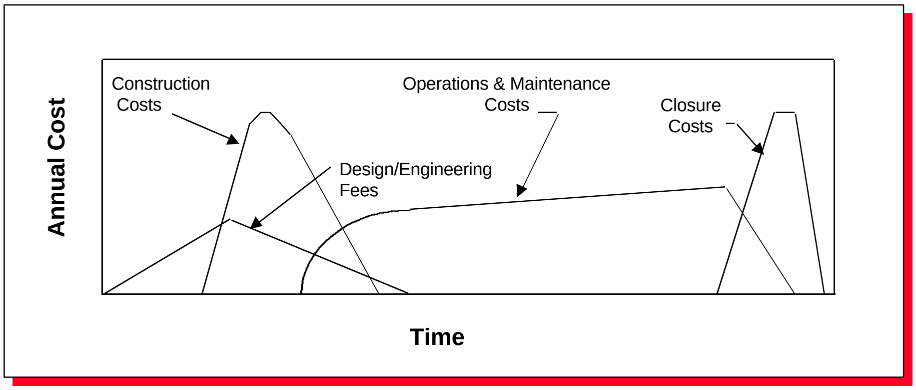
Section 1.4: Life Cycle of Environmental Restoration Projects/Lessons Learned

Life-Cycle Costs



11

- A project's life cycle extends from the Concept Phase through the Close-Out Phase, and, as applicable, includes separate costs estimates for each major project phase.

- DOE Order 430.1, *Life-Cycle Asset Management*, requires that DOE program/project managers use a systems engineering approach to project planning and execution. A key component to the systems engineering approach is to provide the technical solutions to functional requirements that minimize costs over the life of the project. The purpose of doing life-cycle cost estimates is the same: find the least costly alternative over the life of the project. As was stated earlier, operations, maintenance, and decontamination and decommissioning should be considered when evaluating all design alternatives.

Note:
Life-cycle costs include the decontamination, decommissioning, and restoration costs.

Notes / Discussion Points / Lessons Learned: ______

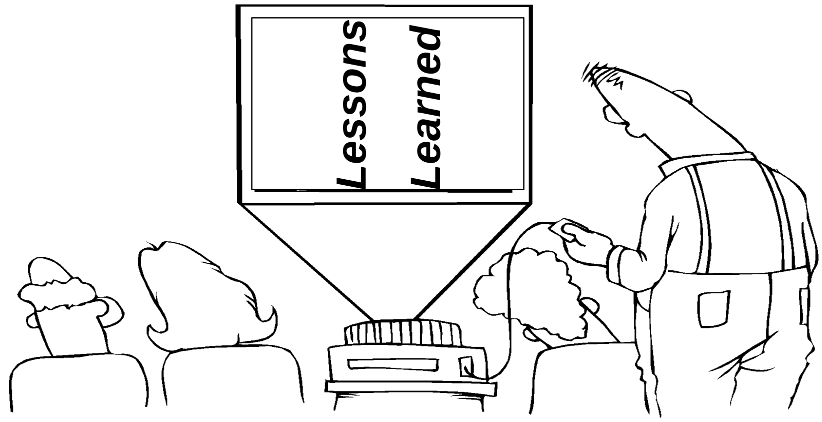
Project Life-Cycle Cost-Estimating Summary

- **Cost estimates serve as backup documentation and justification for baselines.**
- **Life-cycle project estimating constitutes the major effort necessary to ensure that a project cost is complete and comprehensive.**
- **The cost planning is for the life of the project rather than for an arbitrary time span.**

12

Notes / Discussion Points / Lessons Learned:

Lessons Learned



13

1. Common errors of project life-cycle costing include the following:
   - Omission of data
   - Lack of a systematic structure or analysis
   - Misinterpretation of data
   - Wrong or misused estimating techniques
   - A concentration on wrong or insignificant facts
   - Failure to assess uncertainty
   - Failure to check work
   - Estimating the wrong items
   - Using incorrect or inconsistent escalation data

   What other errors have you encountered?

2. What was done to alleviate these errors?

3. How are problems/errors such as these addressed when they are learned?

4. What if the error was made long ago?

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

5. What steps are being taken to ensure that similar mistakes do not occur?

6. Is there any confusion in what the life cycle of a project includes and how cost-estimating should be performed?

7. Has the new Life-Cycle DOE Order confused or helped clarify things?

   Are there places where improvements could be made?

8. Does anyone have problems or issues that arise in moving through the cycles of a project?

   Is it clear when you transition from one phase to the other?

   How do you document those changes?

   What parameters or changes do you make to the data or techniques and methods?

   When do you transition to the next phase?

9. What problems have been experienced in defining what the project life should be? What is the "useful life span?"

10. How does the cost estimate ensure that life-cycle items such as user fees, salvage receipts, and power revenues are included?

11. How is long-term surveillance/maintenance addressed? What is a better approach?

12. Are life cycle cost estimates always required? When should they not be required? Are they always generated? If not, why?

Notes / Discussion Points / Lessons Learned: ______________________________

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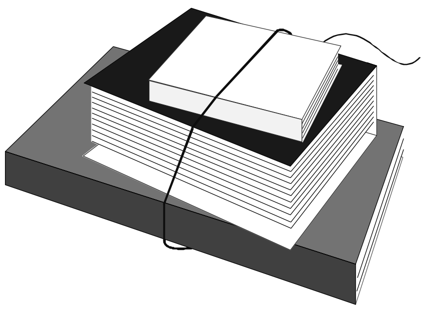
Section 1.5

Types of Cost Estimates/ Lessons Learned



1

This section compares traditional construction, DOE construction, and Environmental Restoration (ER) and Waste Management (WM) projects for the following types of estimates:

- Order of Magnitude/**Planning/Feasibility Study**
- Budget/Conceptual/**Preliminary**
- Definitive/**Detailed**

Notes / Discussion Points / Lessons Learned:

Estimate Types

	Industry Standard	DOE Construction	DOE ER - Assessment Phase	DOE ER - Clean-Up Phase
Level of detail and reliability increases	Order of Magnitude	Planning/Feasibility Study	**Planning**	**Planning**
		Budget/Conceptual Design		**Feasibility**
	Budget	Preliminary Design (Title I)	**Preliminary**	**Preliminary**
	Definitive	Detailed/Design Estimate (Title II)	**Detailed**	**Detailed**

2

Discussion Leader/Facilitator Notes: The facilitator should reinforce the fact that this chart clearly presents differences that exist in the terms used and how estimate types are defined. Project managers need to be aware that people may be using terms differently. The table above was referenced from the "DOE Cost Estimating Guide" (DOE G 430.1-1).

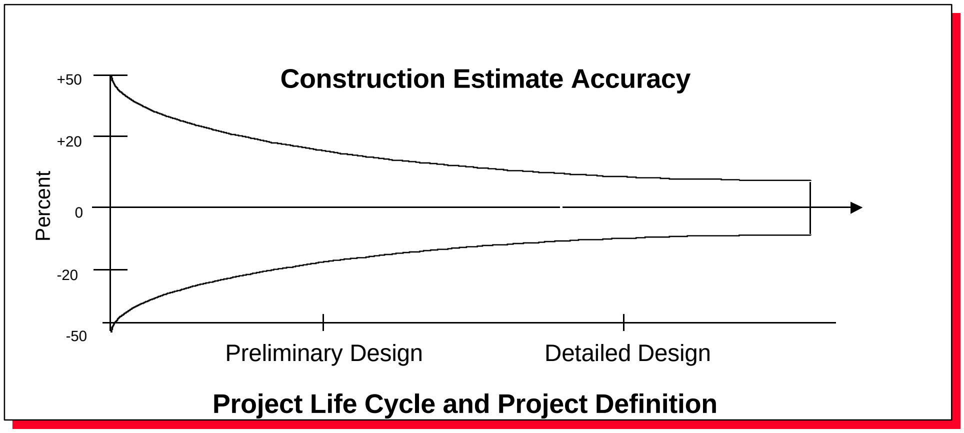
This chart compares the terms used for estimate types by DOE Construction and Environmental Restoration to traditional industry terms Association for the Advancement of Cost Engineering, International (AACE). This chart clearly points out why confusion often exists in how we categorize or what we call an estimate. Because communication is vital to project and program managers, one must understand that differences exist in estimate-type terms.

- The levels of accuracy and confidence in the estimate are based on the type and detail of the estimate. They increase in accuracy as the project life cycle increases.
- The accuracy of the estimate depends on both the amount of quality information available and the judgment and experience of the estimator. As the amount of information and specific details increases, so does the degree of accuracy.
- Each type of estimate has a separate purpose, basis, and design scheme.

Notes / Discussion Points / Lessons Learned: ______________________________

Section 1.5: Types of Cost Estimates/Lessons Learned

Estimate Accuracy for DOE Construction Projects



3

Discussion Leader/Facilitator Notes: The facilitator should point out that they may also see this graph showing a beginning range of +50% and -30%, instead of +50% and -50%. Industry standards typically assume an initial range of +50% and -30%.

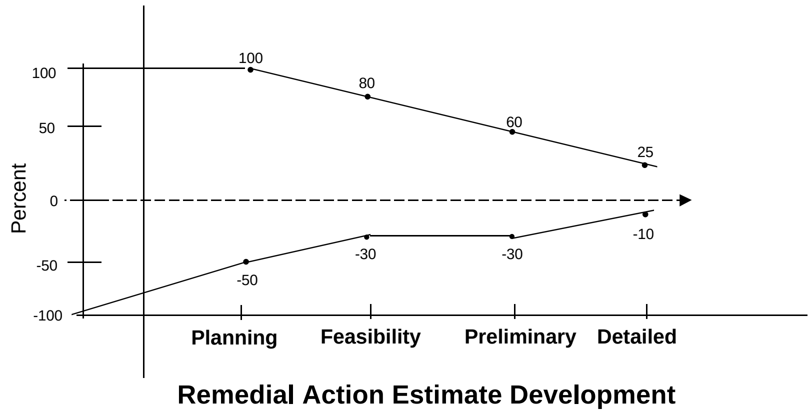
This graph depicts a DOE construction-type project life-cycle estimate accuracy range. Industry standards depict this same graph but show an initial range of +50% and -30% instead of +50% and -50%.

- As the project progresses through its life cycle and project definition improves, the accuracy of the estimate will also improve.
- When preparing estimates, you should always strive for the best and most accurate cost estimate possible given the data available.
- Note that the accuracy range provided includes the estimate for contingency. Therefore, the total estimate, including contingency, should establish the upper bound of the estimate based on the technical scope and schedule.

Notes / Discussion Points / Lessons Learned: ______________________________

Estimate Accuracy for Remedial Actions

ER Cost Estimate Accuracy



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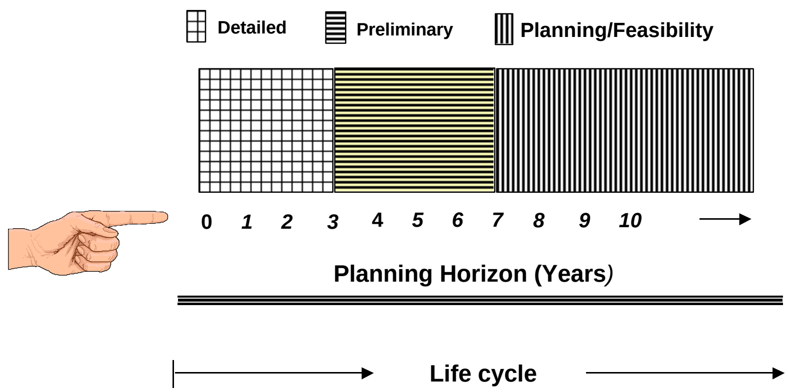
- This graph depicts a remedial actions-type project life-cycle estimate accuracy range.
- Estimate accuracy ranges are based on estimate accuracy for environmental restoration per DOE G 430.1-1, *Cost Estimating Guide*.

Notes / Discussion Points / Lessons Learned: ______________________________

Estimate Accuracy Changes Over Time



5

Discussion Leader/Facilitator Notes: Introduce the term "life cycle" here.

Life-cycle cost estimates encompass all costs associated with an ER project from the beginning of assessment to the end of remedial action, including postclosure and verification activities. Life cycle is defined by life cycle asset management (DOE Order 430.1) as "the life of an asset from planning through acquisition, maintenance, operation, and disposition."

Notes / Discussion Points / Lessons Learned: ______________________________

Section 1.5: Types of Cost Estimates/Lessons Learned

Estimate Types and Their Applications

Order-of-Magnitude/Planning/Feasibility Study

Industry Standard		**DOE Construction**		**Environmental DOE Restoration-Assessment Phase**		**Environmental DOE Restoration-Clean-up Phase**	
Purpose	**Accuracy Range**	**Purpose**	**Accuracy Range**	**Purpose**	**Accuracy Range**	**Purpose**	**Accuracy Range**
Order of Magnitude 1. Assess project feasibility 2. Screen alternative designs (also referred to as "conceptual" or ball park)	+ 50% to - 30%	**Planning** 1. Scoping Studies 2. Preliminary budget estimates of Total Project Cost 3. Support Critical Decision 0	+ 50% to - 50%	**Planning** Assist in the preliminary planning and budgeting of a project	- 50% to + 100%	**Planning** 1. Assist in preliminary planning and budgeting of the cleanup. 2. Required for budgetary purposes for inclusion in planning documents. 3. Included in the EM 5-Year Plan. 4. Basis for funds represented in the ADSs.	- 50% to + 100%
						Feasibility Used to evaluate the numerous technical solutions developed to remediate a site.	- 30% to + 80%

6

Discussion Leader/Facilitator Notes: The facilitator should again point out the differences between how DOE and industry define estimate types. Understanding these differences may eliminate communication problems.

The industry standards used are AACE. The DOE definitions are obtained from the DOE G 430.1-1, "Cost Estimating Guide." Participants should note that outside auditors need to be reminded of the acceptable cost-estimate ranges approved by DOE.

This table compares the industry standard definition of an order-of-magnitude estimate with how DOE defines a planning/feasibility estimate for construction and environmental restoration projects.

- **Industry Standard Order-of-Magnitude Estimate** (sometimes referred to as "conceptual" or "ball park")
  - — Purpose: These estimates are made without detailed engineering data. They have important applications, including use in determining quickly the feasibility of a project or screening several types of alternative designs.

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Notes / Discussion Points / Lessons Learned: ______________________________

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— Basis: The basis for an order-of-magnitude estimate must describe the purpose of the project, basic criteria, significant features and components, proposed methods of accomplishment, and proposed construction schedule. Order-of-magnitude estimates are based on cost-capacity curves, ratio estimates, and other cost-estimating relationships based on past history and expert opinion.

- **DOE Construction - Planning Estimate**
  — Purpose: These estimates are normally prepared for a proposed project before the conceptual design is completed. They are used for scoping studies and for preliminary budget estimates of total project costs. They should support Critical Decision 0.
  — Basis: The basis for the planning estimate must describe the purpose of the project, general design criteria, significant features and components, proposed methods of accomplishment, proposed construction schedule, and any known research and development requirements. Any assumptions that the estimator makes in this phase shall be documented for review and concurrence. Planning estimates are based on past cost experience with similar type facilities, where available.

- **DOE Environmental Restoration Assessment Phase - Planning Estimate**
  — Purpose: The planning estimate assists in the preliminary planning and budgeting of the project.
  — Basis: The basis for the planning estimate is very limited because a large amount of information is unknown and/or highly uncertain. Only the location of the work, likely contamination, and prior use of the land may be known. Therefore, analogies, simple cost-estimating relationships, and more sophisticated parametric tools are uses for the estimate.
  — When sufficient detail is unavailable, historical data may be used.

- **DOE Environmental Restoration Clean-up Phase Planning Estimate**
  — Purpose: The planning estimate is required for budgetary purposes or for inclusion in planning documents. This estimate is the basis for the funds represented in the Activity Data Sheets (ADSs).

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Notes / Discussion Points / Lessons Learned: ______________________________

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— Basis: Minimal design information is available; therefore, use of historical cost data is helpful. All information gathered during the Assessment Phase is used in the computation of this estimate.

- **Feasibility Estimate**

— Purpose: Feasibility estimates are used to evaluate and compare potential options or alternatives, including numerous technical solutions developed to remediate a site. Because of the early time period in the project life cycle during which these estimates are made, they usually have an order-of-magnitude level of accuracy. These estimates perform two functions: (1) they present a total estimated cost of each alternative on the basis of the best information available, and (2) they provide a logical, traceable framework for comparing alternatives with each other.

These estimates can be used to establish the probable, costs of a program/project budget, evaluate the general feasibility of a project, evaluate cost consequences of proposed modifications, establish a preliminary budget for control purposes during the design phase, and screen a number of alternative projects so one or more can be given a more detailed examination.

— Basis: Use the lowest level of detail possible and takeoffs from available drawings.

Notes / Discussion Points / Lessons Learned: ______________________________

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Estimate Types and Their Applications

Budget/Conceptual/Preliminary

Industry Standard		DOE Construction		Environmental DOE Restoration - Assessment Phase		Environmental DOE Restoration - Clean-up Phase	
Purpose	**Accuracy Range**	**Purpose**	**Accuracy Range**	**Purpose**	**Accuracy Range**	**Purpose**	**Accuracy Range**
Budget 1. Budget preparation 2. Planning estimate	-15% to + 30%	**Conceptual Design Estimate** 1. Ensure project feasibility 2. Develop reliable project cost estimate 3. Establish baseline project definitions, schedules, and costs 4. Support Critical Decision 1 (design 10% to 15% complete)	± 30%	**Preliminary** Used as a budgetary tool and are included in the EM 5-Year Plan.	- 30% to + 70%	**Preliminary** A more detailed cost estimate that is developed after a remediation alternative is selected.	- 30% to + 60%

9

Discussion Leader/Facilitator Notes: The facilitator should again point out the differences between how DOE and industry define estimate types. Understanding these differences may eliminate communication problems.

The industry standards used are AACE. The DOE definitions are obtained from DOE G 430.1-1, "Cost Estimating Guide." Participants should note that outside auditors need to be reminded of the acceptable cost-estimate ranges approved by DOE.

This table compares the industry standard definition of a budget estimate with how EM-40 defines a conceptual and preliminary estimate for environmental restoration projects.

- **Industry Standard - Budget Estimate**
  - — Purpose: A Budget Estimate is used in establishing the owner's budget or planning purposes.
  - — Basis: This estimate is developed with the help of design flow diagrams, layouts, and equipment details. In other words, enough preliminary engineering has taken place to define further the project scope.

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Notes / Discussion Points / Lessons Learned: ______________________________

- **DOE Construction - Conceptual Design Estimate**
  - — Purpose: A Budget/Conceptual Design Estimate is required to request Congressional authorization for funding. This request is required for each Line Item Construction Project and each contingency-type project. The fundamental purposes of a Budget or Conceptual Design estimate are as follows:
    - To ensure project feasibility and attainable performance levels;
    - To develop a reliable project cost estimate consistent with realistic schedules;
    - To establish baseline project definitions, schedules, and costs; and
    - To support Critical Decision 1.
  - — Basis: The basis for a Budget or Conceptual Design Estimate shall include as many of the detailed requirements in the Conceptual Design Report (CDR) as possible.

- **DOE Environmental Restoration Assessment Phase - Preliminary Estimate**
  - — Purpose: A more detailed estimate can be completed after some basic information is available from a preliminary assessment or site inspection. Preliminary Estimates are used as a budgetary tool.
  - — Basis: This estimate is developed after the preliminary assessment is completed. The estimate is more detailed. Unit cost is applied at this point to some project categories in the assessment phase, such as laboratory analysis and monitor well drilling.

- **DOE Environmental Restoration Clean-up Phase - Preliminary Estimate**
  - — Purpose: After a remediation alternative is selected, a more detailed cost estimate is developed. This estimate shall be in sufficient detail that it can be used as one of the project control tools.
  - — Basis: This estimate shall show all costs incurred to date. All future estimated costs—such as equipment costs, vendor pricing, or materials pricing—shall be as accurate as possible.

Notes / Discussion Points / Lessons Learned: ____________________

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Section 1.5: Types of Cost Estimates/Lessons Learned

Estimate Types and Their Applications

Definitive/Detailed							
Industry Standard		DOE Construction		Environmental DOE Restoration - Assessment Phase		Environmental DOE Restoration - Clean-up Phase	
Purpose	Accuracy Range	Purpose	Accuracy Range	Purpose	Accuracy Range	Purpose	Accuracy Range
<u>Definitive</u> 1. Bid estimates 2. Construction estimates 3. Control estimates	+ 15% to - 5%	<u>Title I Estimate</u> 1. Verify that Title I details remain within project funding. 2. Support Critical Dec. 2 (Design 25% to 35%comp.)	± 20%	<u>Detailed</u> Used to decide alternatives for remediating a site.	- 25% to + 55%	<u>Detailed</u> Verify the contractor's figures in lump sum and negotiated fee projects.	- 10% to + 25%
		<u>Title II Estimate</u> 1. Accurate estimate of construction cost, before the competitive bidding and construction activities. 2. Support Critical Dec. 3 (Design 60 to 100% comp.)	- 5% to + 15%				
		<u>Construction Estimate</u> 1. Estimate is based on bid information (Design 100% complete)	- 5% to + 10%				

11

Discussion Leader/Facilitator Notes: The facilitator should again point out the differences between how DOE and industry define estimate types. Understanding these differences may eliminate communication problems.

The industry standards used are AACE. The DOE definitions are obtained from DOE G 430.1-1, "Cost Estimating Guide." Participants should note that outside auditors need to be reminded of the acceptable cost-estimate ranges approved by DOE.

This table compares the industry standard definition of a definitive estimate with how EM-40 defines a detailed estimate for environmental restoration projects.

- **Industry Standard - Definitive Estimate**
  - —Purpose: A Definitive Estimate is used for many purposes, including bid proposals and control estimates
  - —Basis: These estimates are prepared from very defined engineering data, including, as a minimum, fairly complete plot plans and elevations, piping and instrument diagrams, single-line electrical diagrams, equipment data sheets and quotations, structural sketches, soil data, sketches of major foundations, and a set of specifications.

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Notes / Discussion Points / Lessons Learned: ______________________

- **DOE Construction - Title I Design Estimate**
  - — Purpose: The Title I Design Estimate is an intermediate estimate used to verify that the Title I design details remain within the project funding. The Title I design details are written in the Title I design phase; this is the initial work accomplished under an approved project.

    The purpose of the Title II Estimate is to estimate construction costs as accurately as possible before competitive bidding and construction activities begin. As Title II design specifications and drawings are developed, the Title II Estimate is completed. The completed Title II Estimate is in support of Critical Decision 3.

  - — Basis: The basis for the Title I Estimates shall include all items mentioned in the Conceptual Design Report estimate basis and all the refinements (developed during the workshop) of producing the Title I Engineering package, including all drawings, outline specifications, data sheets, bills of material, schedule refinements, definitions of scope, methods of performance, changes in codes, standards, and specifications.

    The basis for the Title II cost estimate must include all of the approved engineering data, methods of performance, final project definition and parameters, project schedule, and final exact detailed requirements.

- **DOE Environmental Restoration Assessment Phase - Detailed Estimate**
  - — Purpose: Detailed Estimates are used to decide between the alternatives for remediating a site. There are numerous detailed estimates, one of each remediation alternative. The Detailed Estimates are the final estimates of the Assessment Phase.
  - — Basis: The basis of the Detailed Estimate includes all information gathered during the Assessment Phase.

- **DOE Environmental Restoration Clean-up Phase - Detailed Estimate**
  - — Purpose: This estimate is used to verify the contractor's figures in both lump sum and negotiated fee projects.
  - — Basis: The basis of the final Detailed Estimate for an environmental restoration project includes the final approved drawings, specifications, calculations, schedule, and expected method of accomplishment of the project goals. This estimate shall be performed as an independent contractor would perform the estimate for bidding purposes.

Notes / Discussion Points / Lessons Learned: ______________________________

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CERCLA Feasibility Study Estimates

By EPA guidance, CERCLA Feasibility Study (FS) Estimates should have an accuracy of at least +50% to -30% (Order of Magnitude)

13

Caution:

- EPA guidance requires that CERCLA Feasibility Study Estimates have an accuracy of at least +50% to -30%, which is an order-of-magnitude accuracy level by industry standards (AACE and PMI). It is not, however, within the accuracy levels of a DOE ER project planning, feasibility, or preliminary estimate.

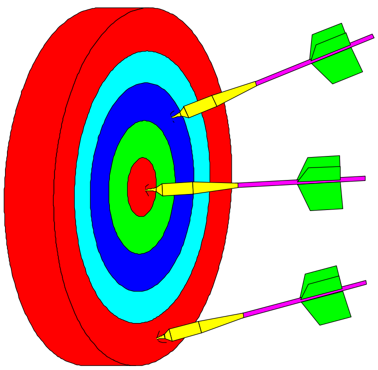
- Superfund EPA *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA/540/G-89/004) page 6-13 states:

> Accuracy of Cost Estimates - site characterization and treatability investigation information should permit the user to refine cost estimates for remedial action alternatives. It is important to consider the accuracy of costs developed for alternatives in the FS. Typically, these "study estimate" costs made during the FS are expected to provide an accuracy of +50 percent to -30% and are prepared using data available from the RI. It should be indicated when it is not realistic to achieve this level of accuracy.

Notes / Discussion Points / Lessons Learned: ______________________

Estimate Type Summary

Terms used in the rest of this workshop



Preliminary

Detailed

Planning/ Feasibility

14

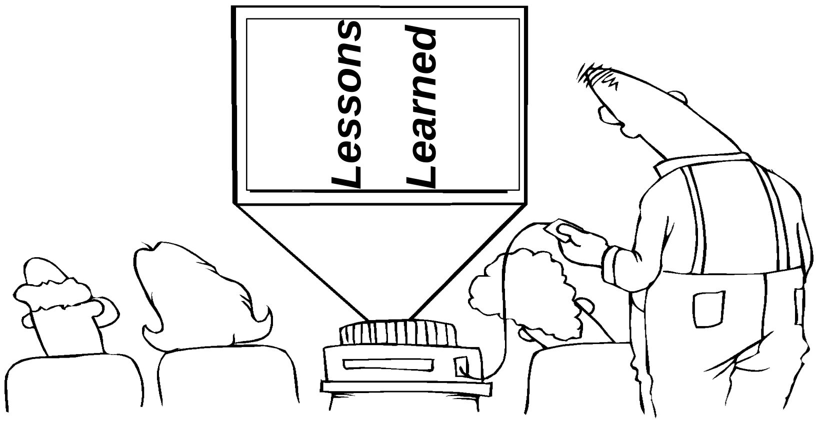
Clearly, terminology can be a problem in communicating something as simple as estimate types. Throughout the rest of this workshop, we will use the following terms:

- Preliminary
- Detailed
- Planning/Feasibility

Notes / Discussion Points / Lessons Learned:

Section 1.5: Types of Cost Estimates/Lessons Learned

Lessons Learned



15

1. What is done/required to ensure that everyone understands and uses the estimate type information?

   How has this created problems or misuse of your estimate?

   What can be done to correct or improve the situation?

2. In obtaining source/comparative data, what problems have you encountered in finding comparative estimates from other organizations and their different titles for different types of estimates?

3. Does everyone agree with the application and use of each type of estimate?

   Have you ever experienced a situation in which a certain type of estimate was used incorrectly?

   Does this happen very often?

   What can be done to prevent it?

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 1.6

Cost-Estimating Methods and Tools/ Lessons Learned

1

This section discusses various cost-estimating methods (ways of generating a cost estimate) and the application of them. It also briefly discusses cost-estimating computer software.

Notes / Discussion Points / Lessons Learned:

Project Planning

1	2	3	4	5

Activities

Project Cost Estimate		Estimate Type
1.	**$**	**Range**
2.	**$**	**Expert Opinion**
3.	**$**	**Bottoms-Up**
4.	**$**	**CER (Computer Generated Models)**
5.	**$**	**CER (Parametric)**
Total	**$**	

2

- Project planning breaks the project into discrete activities (major components, building blocks, scope elements, etc.).

- The cost estimate is developed by estimating the activities using various cost-estimating methods. The activities are subtotaled to develop the total project cost.

Notes / Discussion Points / Lessons Learned:

Techniques

Cost-estimating techniques and methods discussed include the following:

- **Activity-Based Cost (ABC) Estimating**
- **Range Estimating**
- **Expert Opinion**
- **Cost-Estimating Relationships**

3

Several techniques are available to help the estimator estimate the cost of a project. Guidance on techniques may be found in DOE Order 5700.2, *Cost Estimating, Analysis, and Standardization.* Based on the project's scope, the purpose of the estimate, and the availability of estimating resources, the estimator can choose one or a combination of techniques when estimating an activity or a project.

The cost-estimating methods discussed and demonstrated on the following pages include:

- Activity-Based Cost (ABC) Estimating
- Range Estimating
- Expert Opinion
- Cost-Estimating Relationships
  - Unit calculations
  - Factors or ratio calculation
  - Indexes
  - Scale of operation/power sizing
  - Parametric
  - Analogy

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ____________________

Section 1.6: Cost-Estimating Methods and Tools/Lessons Learned

DOE G 430.1-1, *Cost Estimating Guide,* provides further detailed explanations of the following techniques used to estimate:

- Bottoms-Up Technique
- Specific Analogy Technique
- Parametric Technique
- Cost Review and Update Technique
- Trend Analysis Technique
- Expert Opinion Technique

Notes / Discussion Points / Lessons Learned:

What is ABC Estimating?

ABC Estimating/Principles and Techniques:

- **Breaks work into discrete, quantifiable activities**
- **Estimates cost at the activity level**

5

- Activity-Based Cost (ABC) estimating is a practical method for preparing cost estimates that breaks work activities into discrete, quantifiable activities.
- The cost of each activity is estimated in terms of requirements for labor and material per unit.
- ABC allows evaluation of all activities required to accomplish a specific task or work activity (e.g., number of samples versus man-hours).
- ABC estimates should be prepared for both traditional "Line Item Projects" and all "Operational" (Direct and Indirect) activities performed on-site.
- ABC estimating improves program management by focusing on activities needed rather than labor availability.

Notes / Discussion Points / Lessons Learned: ______________________________

ABC Estimating Method

Purposes and Benefits:

- **To improve cost and schedule estimates**
- **To provide a method for measuring and reporting performance**
- **To provide justifiable cost estimates and identify cost drivers**
- **To improve program/project management**
- **To provide traceability, defensibility, and accountability**
- **To tie to a standard cost structure**

6

The purposes and benefits of the ABC estimating method are as follows:

- To improve cost and schedule estimates
- To provide a method for measuring and reporting performance
- To provide justifiable cost estimates and identify cost drivers
- To improve project management/configuration management
  - Focuses on activities needed rather than on labor availability
  - Provides an opportunity to perform a critical analysis of all activities (and identify potential programmatic cost savings)
- To provide traceability to back-up and support documentation and allow for focused defensibility of different elements of the cost estimate.
- To tie the estimate to the cost/scope structures (e.g., HTRW, RACER, project life-cycle cost structure, etc.).

Notes / Discussion Points / Lessons Learned: ____________________

ABC Estimating Method

Defined by equation:

$$C/A = HD + M + E + S\,.$$

Where

C/A =estimated cost per activity

H = labor hrs to perform activity once

D = labor rate ($/hr)

M = material cost to perform activity once

E = equipment costs to perform activity once

S = subcontract cost to perform activity once

7

Calculation: The estimated cost per activity equals the addition of labor cost (labor hrs x labor rate), material cost, equipment costs, and subcontract cost to perform the activity once.

$$C/A = HD + M + E + S\,.$$

- The total cost for performing the activity will be based on the number of times the activity is performed during a specific time frame.

- Cost estimators have assembled large data bases of activity-based cost information. The R.S. Means Company updates its published cost references annually, and they are an excellent source of ABC information for the construction industry.

Example of an ABC Estimate (Chapter 24 of the DOE G 430.1-1, *Cost Estimating Guide*)

- To get a better understanding of how an ABC estimate is developed, assume that you have been asked to prepare a cost estimate for a site evaluation. To verify that no contamination exists at the site, subsurface soil samples will have to be collected. The area of the site is known, and the guidelines for the number of samples per unit area has also been given.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

- **Site**: Atlas Metals (now out of business)

- **Objective:** Collect and analyze subsurface soil samples to determine if contamination exists from past usage of the 1,000 ft^2 area.

- **Sampling Requirements**: One sample per 100 ft^2, and sample depth is 5 ft.

- The activity involves the following:
  - — Mobilize equipment and personnel
  - — Drill hole for sample
  - — Collect sample
  - — Decontaminate equipment between samples
  - — Prepare all samples for analysis
  - — Demobilize equipment and personnel
  - — Analyze samples

- The auger requires two people to operate it. Site mobilization and demobilization (mob/demob) will take a total of 1 hr. A 2-man crew can drill one hole, collect the sample, and decontaminate the equipment in 1 hour. The local labor rate is $15.00/hr for all disciplines. A 2-person crew can prepare 10 samples for analysis in 1 hr.

- Material needs are as follows:
  - — Sampling containers and labels ($1.00/sample)
  - — Safety equipment for site personnel (gloves, safety glasses, and protective equipment at $10.00/person/day)
  - — Water to clean the auger between samples (5 gal/sample at $0.30/gal)

- Equipment needs are as follows:
  - — Hand-held auger for sample collection ($100.00/day flat rate)

- The laboratory (subcontractor) charges $1,000.00/sample for analysis.

- Overhead multipliers:
  - — Labor overhead is 150%, which is a 2.5 multiplier.
  - — Material overhead and taxes is 20%, which is a 1.2 multiplier.
  - — Equipment overhead and taxes is 20%, which is a 1.2 multiplier.
  - — Subcontract overhead markup is 15%, which is a 1.15 multiplier.

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Notes / Discussion Points / Lessons Learned: ______________________________

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Number of hours required to perform the activity = 1 hr mob/demob + (1 hr/sample x 10 samples) + 1 hr prep sample = 12 hrs

Wages per labor hour = 2 people x $15.00/hr x 2.5 overhead = $75.00/hr

Labor cost per sample = (12 hrs x $75.00/hr) ÷ 10 samples = $90.00/sample

Materials costs = [(10 samples x $1.00/sample) + (2 people x 2 days x $10.00/person) + (10 samples x 5 gal/sample x $0.30/gal.)] x 1.2 material overhead and taxes = $78.00

Materials cost per sample = $78.00 ÷ 10 samples = $7.80/sample

Equipment costs = (2 days x $100.00/day) x 1.2 equipment overhead and taxes = $240.00

Equipment cost per sample = $240.00 ÷ 10 samples = $24.00/sample

Subcontractor (laboratory cost) cost per sample = $1,000.00/sample x 1.15 subcontract overhead markup = $1,150.00/sample

C/A = (HD + M + E + S)/sample

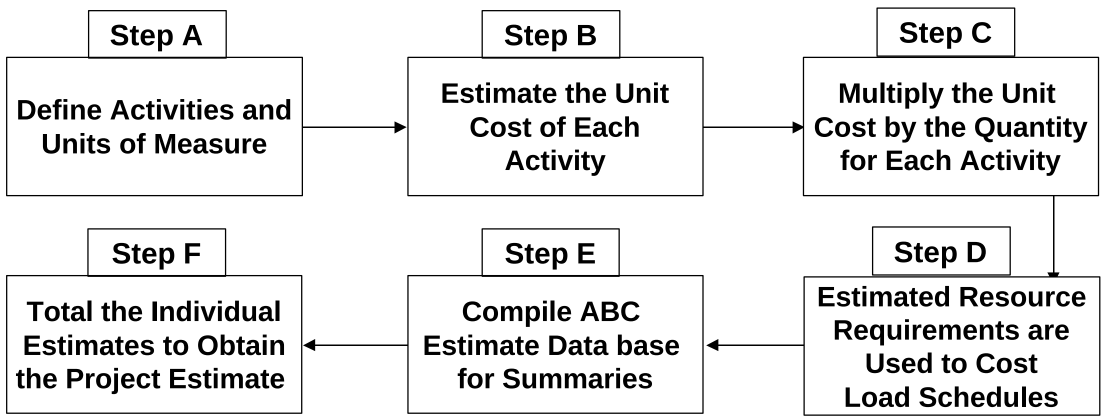
C/A = $90.00 labor cost/sample + $7.80 material cost/sample + $24.00 equipment cost/sample + $1,150.00 subcontractor cost/sample = $1,271.80/sample

If the area requiring sampling increases or decreases, the number of samples can be recalculated using this ABC.

Notes / Discussion Points / Lessons Learned: ______________________________

ABC Estimating Method

Process Flow



10

The process flow for the ABC estimating can be defined in the following steps.

- Step A: Define activities for the project and units of measure for each activity.
- Step B: Estimate the unit cost of each activity.
- Step C: Multiply the unit cost by the quantity for each activity.
- Step D: Estimated resource requirements are used to cost load schedules.
- Step E: Compile the ABC estimate data base for summaries.
- Step F: Total the individual estimates to obtain the project estimate.

Notes / Discussion Points / Lessons Learned:

ABC Estimating Method

Considerations for Identifying Activities

- **Development of activities is driven by technical scope.**
- **Defining an activity implies that it is a measurable unit of work.**
- **Activities are defined in terms of work output or labor hours to perform a specific activity.**
- **The level of detail for estimate preparation can differ from the level of detail for cost collection.**
- **Activities can be Level of Effort (LOE).**
- **Avoid excessive detail and broad generalizations.**
- **Include logically related work.**
- **Account for all work activities/tasks.**
- **Avoid overlap between activities.**
- **Define units of measure and associated quantities.**

11

- Development of activities is driven by technical scope.
- Defining an activity implies that it is a measurable unit of work.
- Activities are defined in terms of work output or labor hours to perform a specific activity.
- The level of detail for estimate preparation can differ from the level of detail for cost collection.
- Activities can be Level of Effort (LOE).
  - — Minimum staffing
  - — Support activities
- Avoid excessive detail and broad generalizations.
- Include logically related work.
- Account for all work activities/tasks.
- Avoid overlap between activities.
- Define units of measure and associated quantities.
  - — Reports written (hours expended per report)
  - — Drums moved (hours expended per drum moved)
  - — Gallons treated (material and equipment costs per gallon treated)
  - — Samples collected (hours per sample collected)

Notes / Discussion Points / Lessons Learned: ____________________

ABC Estimating Method

Developing Unit Cost Estimates for activities:

- **After an activity is identified, it must be quantified in terms of cost elements required to conduct that activity.**
- **Unit costs are:**
  - — **Associated with ongoing operations**
  - — **Evaluated against available industry or commercial standards**

12

After an activity is identified, it must be quantified in terms of cost elements required to conduct that activity (e.g., labor hours per unit of work, material costs per unit of work, subcontractor costs per unit of work, and equipment usage costs per unit of work).

- Unit costs for activities associated with ongoing operations should be based on actual historical cost data from those operations collected at the activity level.
- Unit costs can also be evaluated against available industry or commercial standards, provided the activities being performed are essentially the same.

Notes / Discussion Points / Lessons Learned: ______________________________

Range Estimating Method

Also called optimistic-pessimistic estimating

- **Simple method of obtaining valuable information from the Program Evaluation Review Techniques (PERT)**
- **Estimate costs within a quantifiable range of:**
  - **— Optimistic**
  - **— Most likely**
  - **— Pessimistic**

13

- The range estimating method, also referred to as optimistic-pessimistic estimating, is a simple and effective method and a useful tool for providing extremely valuable information about the cost of a project.
- Range estimating was borrowed from the Program Evaluation Review Techniques (PERT) that established schedule critical path analysis by estimating activity durations in optimistic, most likely, and pessimistic values and calculated an expected activity duration from these values. It uses a beta distribution of

$$\text{Expected Value} = \frac{\text{optimistic} + (4 \times \text{most likely}) + \text{pessimistic}}{6}$$

  This idea or approach is used in range estimating.

- In range estimating, the following three-point estimates are developed:
  - — Optimistic: The optimistic condition is specified as a value that has 1 chance in 20 of being exceeded by the actual outcome. A good operational definition is that the optimistic estimate is the cost when everything is occurring as well as can be expected.

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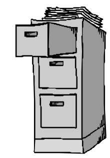
Notes / Discussion Points / Lessons Learned: ______________________________

- Most likely: The most likely condition is specified as the best estimate under normally expected conditions.

- Pessimistic: The pessimistic condition has 19 chances out of 20 of being exceeded by the actual outcome. In operational terms, the pessimistic estimate is the value when things go about as poorly as can be expected.

$$\text{Expected Value} = \frac{\text{optimistic} + (4 \times \text{most likely}) + \text{pessimistic}}{6}$$

Reminder: assumptions that support the estimate should be documented.



Notes / Discussion Points / Lessons Learned: ______________________________

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Range Estimating Method

Uses for Range Estimating:

- **Given limited scope, obtain an expected value estimate.**
- **Explore the sensitivity of the project estimate to various factors.**

15

Several uses exist for range estimating. Two primary uses are as follows:

- Given limited scope, evaluate risk and obtain an expected value estimate by evaluating optimistic, most likely, and pessimistic values for the scope of work.
- Explore the sensitivity of one or more factors in the estimate in both an optimistic (favorable) direction and a pessimistic (unfavorable) direction to investigate the effects of these changes on the estimate.

Conditions and application of these two uses are discussed in greater detail on the following pages.

Notes / Discussion Points / Lessons Learned: ____

Range Estimating Method

Use 1: Given limited scope, obtain an expected value estimate.

- **Used during the planning phase of a project in the absence of other methods**
  - **— Rough idea of the "window of cost" for project based upon the design data available and the scope of work known**
- **Estimate optimistic, most likely, and pessimistic conditions. Calculate the expected value estimate.**

16

Use 1: This purpose uses range estimating to provide an expected value estimate when scope definition is limited.

- Data are available when range estimating is used for this purpose:
  - — Some but limited technical data
  - — Poorly defined scope for at least some phases
  - — Historical data or expertise on similar efforts
- The scope of work/WBS elements are evaluated to determine:
  - — "Effort Required" and a "Degree of Confidence" (+/- percentage) for each
  - — Optimistic, pessimistic, and most likely estimates for each element (Program Evaluation Review Technique)

$$\text{Expected value} = \left(\frac{\text{optimistic} + 4 \text{ x (most likely)} + \text{pessimistic}}{6}\right).$$

Notes / Discussion Points / Lessons Learned:

Range Estimating Method

Use 2: Explore the sensitivity of one or more factors.

17

Use 2: This purpose uses range estimating to evaluate the sensitivity of factors on the project costs.

- Data are available when range estimating is used for this purpose:
  - — The scope definition can be of various ranges or types of estimates but most often is well defined.
  - — Analyses to evaluate risk for contingency applications.
  - — Sensitivity analysis to determine the impact of factors or conditions before project execution so that the project team can be aware of sensitivities and can drive the project in the direction of success.

- Steps for evaluating sensitivity:

  1. Determine project factors or elements that affect project cost.

  2. Arrange the factors or elements on an ordinal scale (ranking scale). A sensitivity analysis can be helpful in evaluating the sensitivity of various factors or elements.

  3. For the top two or three factors, develop the three-point estimates (optimistic, most likely, and pessimistic).

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Notes / Discussion Points / Lessons Learned: ______________________________

Section 1.6: Cost-Estimating Methods and Tools/Lessons Learned

Factor 1

Factor 2	Optimistic	Most Likely	Pessimistic
Optimistic			
Most Likely			
Pessimistic			

*** Total project estimate with factor = 1 and 2 both at optimistic and the rest of the conditions most likely.**

4. Calculate the total project cost for each combination of estimates such as to obtain a matrix the (the matrix for two factors is shown).

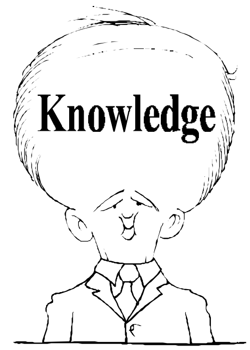
5. Arrange the results for interpretation.

6. Evaluate what conditions result in unacceptable outcomes, and determine how these factors can be driven toward success.

Notes / Discussion Points / Lessons Learned: ________________________________

Expert Opinion Method

- **Purpose: To get an idea of the cost of an activity or project**
- **Best used when other techniques or data are not available, (e.g., at the preconceptual phase)**
- **Limitations**
  - **— Reliant on someone's opinion and knowledge**
  - **— No real data available**



19

Estimates developed using the expert opinion method are just that — the opinion of experts about what something will cost. They are accurate only to the extent that the experts are truly experts (have a wide range of experience in the kind of project being estimated) and the project does not differ from their experience.

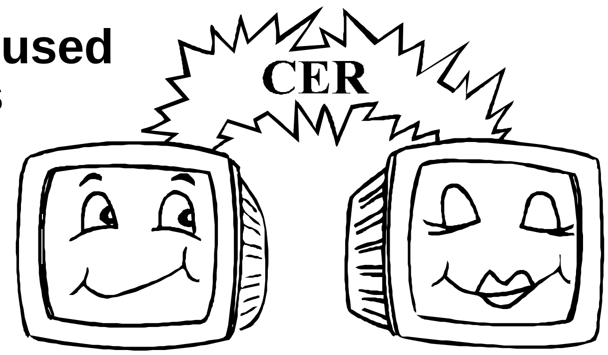
- Expert Opinion Method: This method may be used when other techniques or data are not available.
- Several specialists can be consulted until a consensus cost estimate is established. Expert opinion estimates tend to become more accurate as more experts are consulted.

Beware of basing funding decisions on expert opinion estimates.

Notes / Discussion Points / Lessons Learned: ________________________________

Cost-Estimating Relationships Method

- **The Cost-Estimating Relationship (CERs) Method can take the form of simple cost factors, equations, curves, nomograms, ratios, and rules of thumb.**
- **They are widely used in various forms of estimating.**



20

- Cost-Estimating Relationships (CERs) can take the form of simple cost factors and ratios to more complex relational equations based on curves.
- CERs are widely used in various forms in estimating. One may safely say that all estimates use some form of CER.
- Some common terms for various CERs include units methods, factors or ratio techniques, scale of operations/power sizing/exponential model, indexes, analogy, and parametric. Each of these terms is discussed on the following pages.

Notes / Discussion Points / Lessons Learned: ______________________________

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Cost-Estimating Relationship Method

Some Common Types of Cost-Estimating Relationship calculations include the following:

- **Unit calculation**
- **Factors or ratio calculation**
- **Indexes**
- **Scale of operations/power-sizing**
- **Parametric**
- **Analogy**

21

Discussion Leader/Facilitator Notes: You will notice redundancy and overlap in the various CER calculations. The important point is to recognize the various terms that may be commonly used.

Each of the calculation of various cost-estimate relationships are discussed in detail on the following pages.

Notes / Discussion Points / Lessons Learned: ____

Cost-Estimating Relationship Method

Unit Calculation

- **Involves using a "per unit factor"**
- **Simply using experience on a particular type of work to relate an end-product units to cost**
- **Example: A 1,000 yd^3 landfill costs \$75,000,000 to remediate; a 1,400 yd^3 landfill could be estimated at 1,400 x \$75,000/yd^3 x escalation or other adjustment factors.**

22

- The unit calculation simply involves using a "per unit factor."
- This practice is simply using experience on a particular type of work to relate end-product units to cost.

Example:

A 1,000 yd^3 landfill costs \$75,000,000 or \$75,000 per yd^3; a 1,400 yd^3 landfill would be 1,400 yd^3 x \$75,000/yd^3, or \$105,000,000.

Notes / Discussion Points / Lessons Learned: ____________________

Cost-Estimating Relationship Method

Factors or Ratio Calculations

- **Provides a convenient means for developing estimates from historical data**
- **Usually associated with order-of-magnitude or planning estimates**
- **Uses a percentage costs as a basis for estimating a specific element**
- **Indexes are usually based on ratios**

23

- The ratio or factor calculation provides a convenient means for developing estimates from historical data.
- This calculation is usually associated with order-of-magnitude or planning estimates; however, it can very often be used for elements of a detailed estimate.
- The ratio or factors calculation uses a percentage as a basis for estimating a specific cost element.

Example:

Equipment is typically 30% of an operating facility's cost. Based on this fact, equipment costs are estimated as a ratio of total costs.

Notes / Discussion Points / Lessons Learned: ______________________________

Cost-Estimating Relationship Method

Index Calculations

An index is a dimensionless number that indicates how the cost of an item changes with respect to a base such as the volume of a building or the square footage of a surface area.

24

Calculation:

$$C_a = C_b \left(\frac{I_a}{I_b}\right),$$

where

I_a = index for cost to be estimated,

I_b = index for reference for which cost of item is known,

C_a = cost of item to be estimated,

C_b = estimated cost of item in base.

Example:

The actual cost of extraction well material for Project A in Aiken, South Carolina, was $540.00/well. Cost is being estimated for a similar extraction well for Project B in Las Vegas, Nevada. The actual cost of Project A material will be adjusted for location differences between Aiken and Las Vegas. The location indexes are

Las Vegas, Nevada = 1.02

Aiken, South Carolina = 0.70

(Indexes obtained from location information in ECHOS 1997)

(Continued on next page)

Notes / Discussion Points / Lessons Learned:

Using these indexes, cost of extraction well material for Project B will be calculated as:

C_B = Cost project B,
C_A = \$540.00,
I_B = 1.02,
I_A = 0.70,

$$C_B = C_A \left(\frac{I_B}{I_A}\right),$$

$$C_B = \$540.00 \left(\frac{1.02}{.70}\right),$$

$$C_B = \$786.86.$$

Comparable cost for extraction well material in Las Vegas = \$786.86.

Published indexes

- *Engineering News Record Construction Index* (incorporates labor and material costs and the Marshall Stevens cost index)
- *Statistical Abstract of the United States* (government indexes on yearly material, labor, and construction cost)
- *Producer Prices and Price Indexes and Consumer Price Index Detailed Report (*published by Bureau of Labor Statistics)
- Location indexes provided in *Published Estimating Standards*

Notes / Discussion Points / Lessons Learned:

Cost-Estimating Relationship Method

Scale-of-Operations/Power Sizing

- **Uses historically derived empirical equations**
- **Recognizes that cost varies as some power of the change in capacity or size**
- **Frequently used for equipment cost estimates**
- **Common factor used is the "six-tenths rule" (establishes the cost-capacity factor at 0.6)**

26

- The Scale-of-Operations calculation (also called Power Sizing of Exponential Model) uses historically derived empirical equations to obtain an estimate of approximate cost from different sizes of the same type of facility or item.

Calculation:

This method recognizes that cost varies as some power of the change in capacity or size.

$$\frac{C_a}{C_b} = \left(\frac{S_a}{S_b}\right)^x,$$

$$C_a = C_b \left(\frac{S_a}{S_b}\right)^x,$$

where C_a = cost for new facility,
C_b = cost for old facility,
S_a = size of new facility,
S_b = size of old facility,
x = cost-capacity factor to reflect economies of scale.

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Notes / Discussion Points / Lessons Learned:

Example:

Make a preliminary estimate of the cost of building a 600-megawatt (MW) fossil fuel power plant. A 200-MW plant was known to cost $100 million 20 years ago when the appropriate cost index was 400, and that cost index is now 1,200. The cost-capacity factor to reflect economies of scale is 0.79.

Solution:

Use the index method to convert the base to current cost, then use the scale of operations to account for the difference in size.

Step 1: $$C_a = C_b\left(\frac{I_a}{I_b}\right) = \$100 \text{ million}\left(\frac{1200}{400}\right) = \$300 \text{ million}$$

Step 2: $$C_a = C_b\left(\frac{S_a}{S_b}\right)^{\mathbf{x}} = \$300 \text{ million}\left(\frac{600}{200}\right)^{\mathbf{0.79}} = \$714 \text{ million}$$

- Commonly used scale of operation factors include the following:
  - — "Six-tenths rule" (x = 0.6)
  - — Nuclear generating plants (x = 0.68)
  - — Fossil-fuel generating plants (x = 0.79)

Notes / Discussion Points / Lessons Learned:

Cost-Estimating Relationship Method

Parametric

- **Requires historical data based on similar projects and reasonable measurements of the quantities/elements of work to be performed**
- **Relies on Cost-Estimating Relationships (CERs)**
- **Suitable for conceptual phase estimates**

28

This type of cost-estimating calculation relies on the development of a cost estimate relationship (CER) based on some gross characteristic of the project. The CER is based on an analysis of many previously completed projects that are similar to the proposed project in scope, function, or materials.

e.g. **Example:**

- Cost-Estimating Relationships (CERs) include the following:
  - — cost per square foot and
  - — cost per cubic yard of cement.

Notes / Discussion Points / Lessons Learned: ______

Cost-Estimating Relationship Method

Analogy

- **Uses similar past projects/efforts as a base for the estimate**
- **Adjusts the previous project's estimated or actual costs by a factor based upon comparative complexity and design, known differences, and geographical and inflation data**
- **Good for scoping studies at preconceptual phase**

29

- The major difference between analogy estimates and parametric estimates is that the parametric estimates use a data base of many completed projects upon which to base the cost estimate, whereas the analogy estimate can use data from as few as one or two completed projects.

- Uses statistical analyses, including regression analysis, to find correlation between costs and performances.

- Requires assessment of differences in project elements/technical features and adjustments necessary to accommodate differences.

- Potential available data include the following:
  - — Process is assumed but substantially unknown,
  - — Very little engineering design is complete,
  - — Very little technical data are available,
  - — Needs reliable estimates or actual costs from previous projects for comparison, and
  - — Standard industrial costs do not take into account special DOE costs such as health and safety and security.

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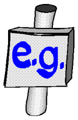
Notes / Discussion Points / Lessons Learned: ____________________

- For analogy estimates, a few similar projects are used as a base, and the estimated costs are increased (or decreased) by some factor, depending on the comparative complexity and known differences between the projects.

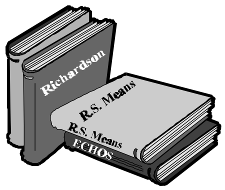


Example:

If a 100,000 ft^2 building was built at a cost of \$110/ft^2 and a similar 200,000 ft^2 building had been built at a cost of \$105/ft^2, an analogy estimate may determine that a similar 150,000 ft^2 building could be built for approximately \$108/ft^2.

Notes / Discussion Points / Lessons Learned: ______________________________

Estimating Tools



Pricing and estimating services/catalogs

Historical data

Estimating software

31

- More common pricing and estimating services and catalogs include the following:
  - — R. S. Means—Means Building Construction Cost Data offer unit price information. Used for complete, finished estimates or for periodic checks of estimates. Unit cost data are organized to conform to the Construction Specifications Institute (CSI) Master Format. City Cost Indexes provide adjustments to specific areas.
  - — The Richardson Rapid System—similar to Means with heavier emphasis on process plant construction.
  - — ECHOS—Environmental Restoration Unit Cost and Assemblies Cost Books published by R. S. Means and Delta Technologies Group, Inc.
- Historical data: Site history records and files
- Estimating software (discussed on next page)

Notes / Discussion Points / Lessons Learned: ______________________

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Estimating Software

"Catalog of Cost-Estimating Models and Evaluation of the Development of a Cost-Estimating Tools Library on Electronic Media"

32

Catalog of Cost-Estimating Models and Evaluation of the Development of a Cost-Estimating Tools Library on Electronic Media is a report prepared by IT Corporation for FM-50 in September 1995. This reference document is an excellent resource on estimating data bases, software programs, and publications.

Example:

Examples of estimating software are Timberline, RACER, MCACES, ECHOS, Success, and CORA. Please consult the reference for more details.

Notes / Discussion Points / Lessons Learned: ______________________________

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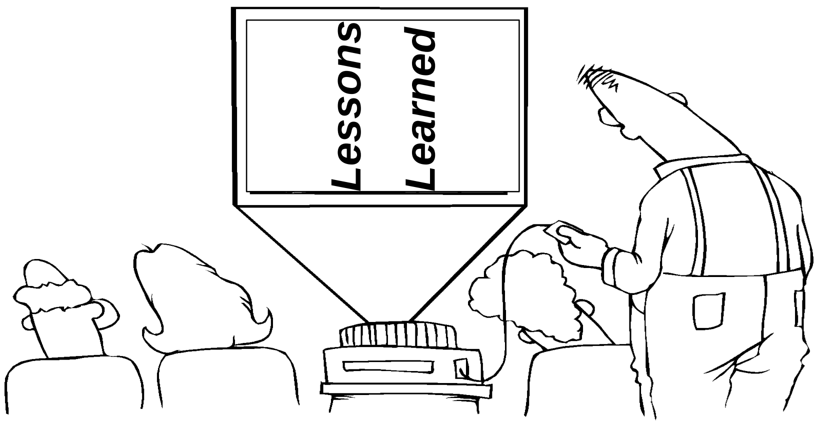
Lessons Learned



33

1. Does everyone agree that ABC estimating improves program management by focusing on activity needed rather than on labor availability?

   Do you think that this focus is good, or are some better ways available for management to use estimates to improve the system?

2. How does your management perform an **analysis** of your cost estimate?

   If so, what programmatic cost savings gains have been realized?

   Are analyses always done?

   If not, is there a gain from them?

3. How many times do you use ABC estimating?

   Where or how could it be used better?

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

4. Does everyone explore sensitivities regularly?

   How do you document this activity?

   If something is identified as very sensitive, how does it get identified to others?

   How is it tracked and satisfied?

5. Are there places in a sound business cycle where sensitives should be used but aren't?

6. What type of historical data does your site maintain?

   Do you use it in your work?

   Who certifies it and ensures its accuracy and how?

7. The current system of collecting costs allows contractors to hide costs so that whether the money being spent is for direct project cost or various "indirect" costs is unclear.

   A uniform and consistent cost-estimating data base system is needed to allow the complex to study other field office cost; perform benchmarking, studies, and trend analyses; and evaluate ways to reduce cost. HCAS has been adopted as that mechanism.

8. What is everyone's opinion of the software they use?

   How do they ensure its accuracy?

   Are the assumptions associated with it traceable to their estimates?

   Where could improvements be made?

   What are the potential faults in your software?

Notes / Discussion Points / Lessons Learned: ____________________

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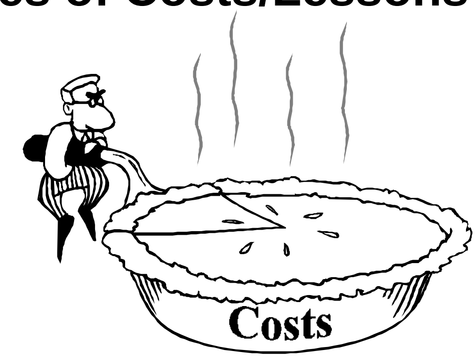
Section 1.7

Types of Costs/Lessons Learned



1

This section will discuss the types of costs included in an estimate.

Notes / Discussion Points / Lessons Learned: ______________________________

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Types of Costs

- **Direct costs**
- **Indirect costs**
- **Escalation costs**
- **Contingency**
- **Net present value**

2

Cost estimates are typically considered to comprise the following types of costs:

- Direct costs
- Indirect costs
- Escalation costs
- Contingency
- Net present value

Each of these types is discussed in detail on the following pages. All Field Offices treat these differently. Please follow the guidance provided at your site.

Notes / Discussion Points / Lessons Learned: ____________________

Direct Costs

Direct Costs Typically Include

- **Labor**
- **Material**
- **Equipment**
- **Subcontracts**

3

- Direct costs are any costs that can be identified specifically with a particular project or activity, including salaries, travel, equipment, and supplies directly benefiting the project or activity.
- The Association for the Advancement of Cost Engineers, International (AACE) defines direct cost as "...costs of installed equipment, material, and labor directly involved in the physical construction of the permanent facility."

Notes / Discussion Points / Lessons Learned: ______________________________

Indirect Costs

Indirect Costs Typically Include

- **Indirect labor**
- **Nonlabor overhead costs**
- **General and administrative costs**
- **Facilities**
- **Taxes**
- **Utilities**
- **Profit**

4

- DOE defines indirect costs as costs incurred by an organization for common or joint objectives and that cannot be identified specifically with a particular activity or project.
- AACE defines indirect costs as "...all costs which do not become a final part of the installation, but which are required for its orderly completion. It includes (but is not limited to): field administration, direct supervision, capital tools, some start-up costs, contractor's fees, insurance, taxes, etc."

Notes / Discussion Points / Lessons Learned:

Escalation

- **Provision is made for increases in the cost as a result of continuing price changes over time.**
- **Cost estimates are usually done in "current" dollars and then escalated to the time the work will be accomplished.**

5

Discussion Leader/Facilitator Notes: Escalation will be discussed in detail, including an example problem, in Section 1.8, Cost-Estimate Process (Detailed Estimate).

- Escalation is the provision in a cost estimate for increases in the cost of equipment, material, labor, etc., as a result of continuing price changes over time.
- Escalation is used to estimate the future cost of a project or to bring historical costs to the present.
- Most cost estimating is done in "current" dollars and then escalated to the time when the project will be accomplished.

Notes / Discussion Points / Lessons Learned: ______________________________

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Contingency

- **Contingency is an integral part of the total estimated cost of a project.**
- **Project and operation estimates will always contain contingency.**

6

Discussion Leader/Facilitator Notes: Contingency will be discussed in detail, with examples, in Section 1.8, Cost-Estimate Process (Detailed Estimate).

- Contingency is an integral part of the total estimated cost of a project. It has been defined as:
  - "[a] specific provision for unforeseeable elements of cost within the defined project scope. [Contingency is] particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur."
- This definition has been adopted by AACE. DOE has elected to narrow the scope of this definition and defines contingency as follows:
  - "Covers costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties within the defined project scope."
  - "The amount of the contingency will depend on the status of design, procurement, and construction; and the complexity and uncertainties of the component parts of the project. Contingency is not to be used to avoid making an accurate assessment of expected cost."

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 1.7: Types of Costs/Lessons Learned

- It is not DOE practice to set aside contingency for major schedule changes or unknown design factors, unexpected regulatory standards or changes, incomplete or additions to project scope definition, or Congressional budget cuts.
- Project and operations estimates will always contain contingency.
- Estimators should be aware that contingency is an integral part of the estimate.

Notes / Discussion Points / Lessons Learned:

Net Present Value

- **CERCLA requires the cost for Feasibility Study cleanup alternatives to be documented in "Net Present Value" dollars.**
- **"Net Present Value" dollars are basically the number of dollars you would have to put in an escrow account to have the sufficient funds to perform the cleanup action at the project's future cleanup date.**
- **This is required as one of the nine criteria required by the Superfund Act to evaluate cleanup alternatives.**

8

To arrive at net present value, the current dollar project costs are time-phased escalated and discounted to present. Escalation is based on DOE-ER escalation rates, and discounting is based on Superfund rates.

Notes / Discussion Points / Lessons Learned: ______________________

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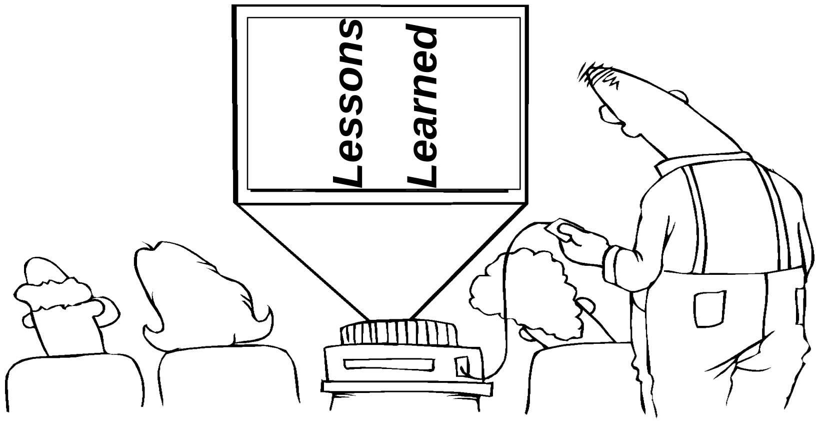
Section 1.7: Types of Costs/Lessons Learned

Lessons Learned



9

1. Some estimators or managers have sought to **hide contingency estimates** to protect the project so that the final project does not go over budget because the contingency has been removed by outside sources. This practice is known as buried contingency. All internal and external estimators should refrain from burying extra contingency allowances within the estimate. A **culture of honesty** should be promoted so that it is unnecessary to bury contingency. In addition, estimators should be aware that estimate reviews will identify buried contingency. The estimate reviewer is obligated to remove buried contingency.

   What have you experienced in this area and what can be done to prevent it?

2. How does your Field Office treat escalation and contingency?

   Which is applied first?

   What is management reserve?

Notes / Discussion Points / Lessons Learned: ____________________

Section 1.8

Cost-Estimate Process (Detailed Estimates)/ Lessons Learned

1

This section discusses the cost-estimate process for detailed cost estimates.

Notes / Discussion Points / Lessons Learned: ______________________________

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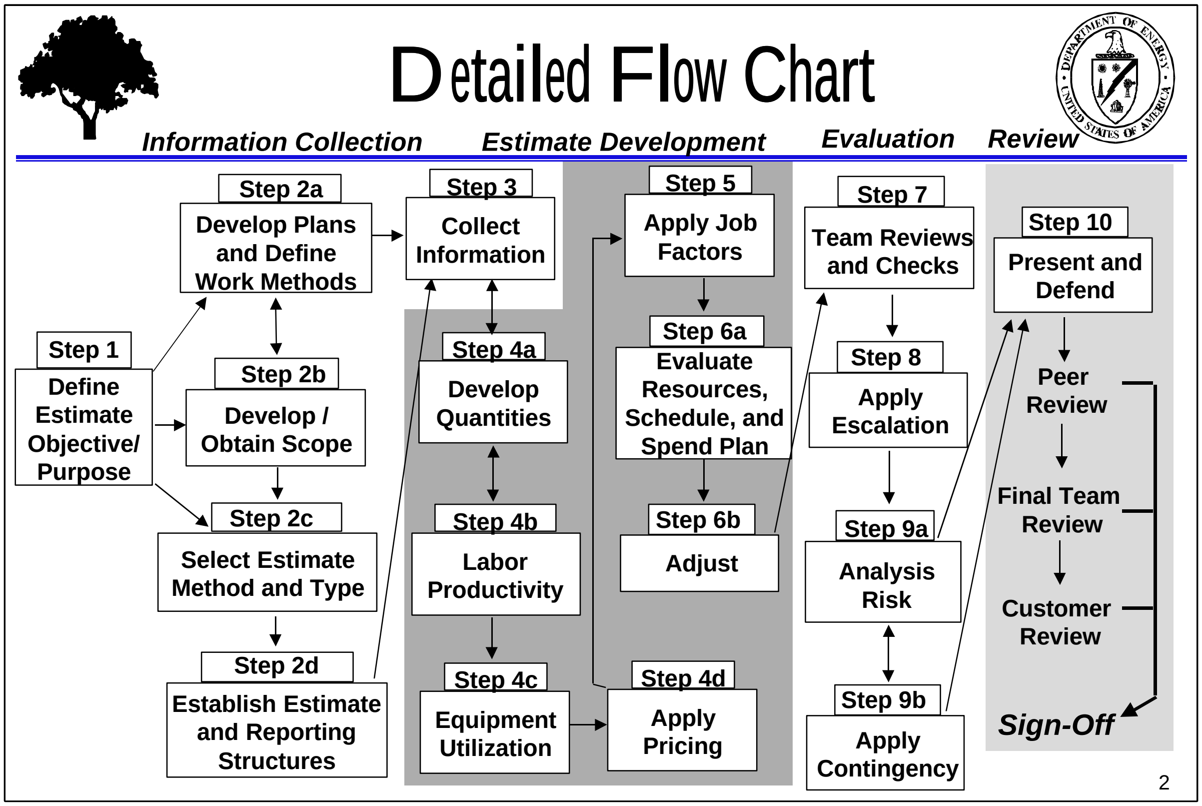
Section 1.8: Cost-Estimate Process (Detailed Estimates)/Lessons Learned



Discussion Leader/Facilitator Notes: The estimating process in not a sequential process. Even though this flow diagram represents the process as discrete steps, one should recognize that the cost-estimation process is an iterative process with many of these steps working concurrently. The facilitator should leave this slide on the second projector so that reference to this process can be identified as each step is discussed.

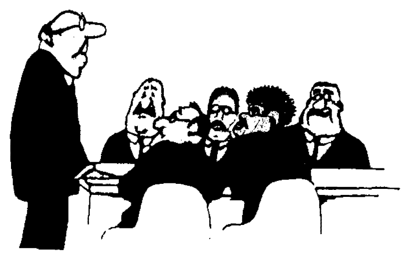
The treatment (order of application) of escalation and contingency vary from one operations office to another. Please follow the guidance provided at your location.

- The Detailed Cost-Estimate process is defined in four primary phases.
  - Information Collection Phase (Step 1 through Step 3)
  - Estimate Development Phase (Step 4 through Step 6)
  - Evaluation Phase (Step 7 through Step 9)
  - Review Processes (Step 10)
- The process for planning and preliminary estimates will primarily differ from the preceding process in the Estimate Development Phase and in the rigor applied in the other phases.
- We will discuss each step of this process.

Notes / Discussion Points / Lessons Learned: ______________________________

Information Collection Phase

Step 1: Define Estimates, Objectives, and Purpose



3

The initial step in the information collection phase is the identification of the estimate objective and purpose, which, along with defining the stage of scope definition for the project, will determine the methodology that will be applicable for doing the estimate.

Notes / Discussion Points / Lessons Learned:

Information Collection Phase

Step 2: (Steps 2a through 2d)

- **2a. Develop Plans and Define Work Methods**
- **2b. Develop/Obtain Scope (who, what, how, when, why)**
- **2c. Select Estimate Method and Type**
- **2d. Establish Estimate and Reporting Structure**

4

The second step in the Information Collection Phase will require:

- 2a. Develop Plans and Define Work Methods Sources, which may include work plans, team meetings and interviews, design documents, and drawings
- 2b. Develop/Obtain Scope

  Who: Project Team Members
  Responsibility Assignment Matrix
  Project Contacts Listing
  Anticipated Workforce Resources

  What: Project Objectives and Accomplishments Contractual
  Framework Requirements and Guarantees
  Project Constraints, Regulatory, and DOE Policy
  External and Internal Deliverables
  Project Procedures
  Funding Source
  Design sketches or drawings
  Site layout, traffic patterns, utility locations, building layout, and elevations

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

What: Floor plan, cross sections, P&IDs, and one-lines
Design basis and assumptions, specifications
Start-up considerations
Determination of quantities
Design/engineering task analysis

How: Project Management Plan
Contracting Strategy
Approach and Operating Philosophy
Program/Project Management Task Analysis
Organization Breakdown Structure
Major Activities
Baseline
WBS
Cost Structure

When: Project Life Cycle
Project/Program/Regulatory Milestone
Overall Planned Schedule Logic (Sequencing Drivers)
Scheduling Constraints

Why: Regulatory Drivers (local, state, and federal)
Stakeholder Input
Internal and External
Project Function
Project-Level Issues to be Resolved

- 2c. Select estimate method (ABC, range, CER, etc.) and type (planning or preliminary) most appropriate to meet the estimate objective and purpose in light of the project scope definition. Even through this is a detailed estimate process, you have to collect information and determine that the detailed estimate is the correct estimate type based on purpose, objective, and scope definition.

- 2d. Establish estimate structure based on work breakdown structure, code of accounts, and reporting structure requirements.

Notes / Discussion Points / Lessons Learned: ______________________________

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Information Collection Phase

Step 3: Collect Information

- **Anything and everything the estimator may need to know should be communicated.**

  <u>Do NOT assume</u> that the estimator already has that information.

6

The collection of information is a step that will actually continue throughout the entire estimate development; however, the estimator does need to identify and collect enough information early, so that the estimating process can proceed in a logical, organized manner.

Examples:

Information includes:

- Project-specific documents and reports such as:
  - Field Work Plans
  - Site investigation reports
  - Feasibility study
  - Record of decision
- Design
  - Sketches of drawings
  - Site layout, traffic patterns, utility locations, building layout, and elevations
  - Floor plan, cross sections, P&IDs, one-lines
  - Design basis and assumptions, specifications
  - Start-up considerations
  - Determination of quantities
  - Task analysis

Notes / Discussion Points / Lessons Learned: ______________________________

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Information Collection Phase

Step 3: Collect Information (continued)

Estimate Kickoff Meeting

- **Develop Plan and Schedule for Creation of the Baseline Estimate**

7

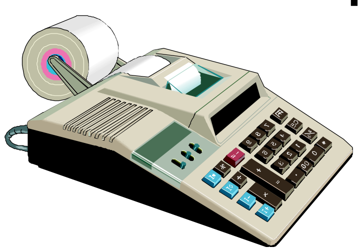
Estimate kickoff meetings are often an efficient and effective way to define and obtain information required for estimate development.

Notes / Discussion Points / Lessons Learned: ____

Estimate Development Phase

Step 4a: Develop Quantities

- **Initial Quantity Determination (Take-offs)**
- **Compilation of Quantities**



8

Discussion Leader/Facilitator Notes: The type of estimate will determine the availability of quantity information (i.e., a planning estimate will most likely be based on calculations or cost estimate ratios of previous or typical projects; detailed estimates will most often require quantity take-offs by the estimator or designer).

The Estimate Development Phase requires the determination of quantities. Quantities may be obtained from:

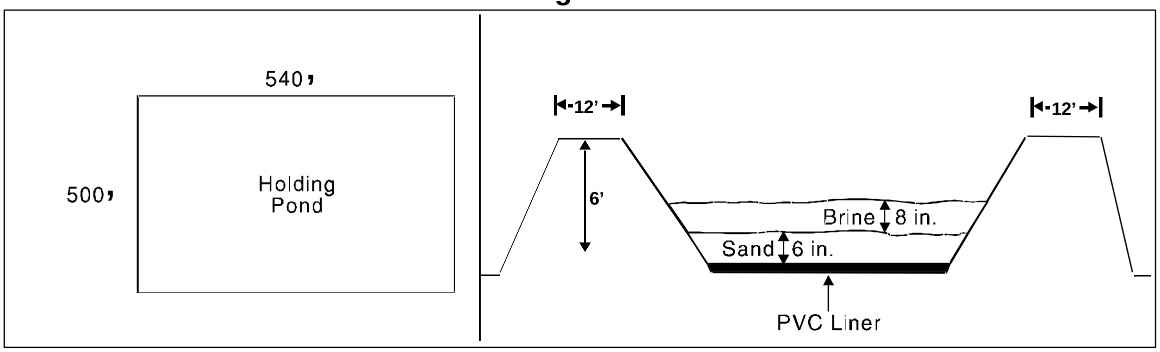
- Quantity take-offs
- Tables or listings of quantities
  - Documents will often include tables of specific quantities such as sampling or analysis required.
  - Designers/engineers may provide bill of materials.
  - Material quantities listings may be provided from computer-aided design.
- Team members may provide input as to the magnitude of quantities
- Calculations/ratios based on previous project data

Notes / Discussion Points / Lessons Learned:

Estimate Development Phase

Step 4a: Develop Quantities Example

Design Sketch



9

Discussion Leader/Facilitator Notes: The facilitator should work through the quantity calculation with the class, explaining how quantities were calculated.

Example:

Given the preceding design drawings, the holding pond is 540 ft x 500 ft.

The pond is surrounded by earthen dikes averaging 6 ft high with side slopes of 1.5:1 (outside) and 3:1 (inside). The width at the top of the dike is 12 ft. The waste material in the pond consists of 8 in. of brine sludge and 6 in. of sand on average. This waste is underlaid by a 10-mil PVC liner.

Calculation: The quantity of material in the dike that surrounds the pond.

Notes / Discussion Points / Lessons Learned:

Calculate

Dike:

Height 6 ft

Length 2 sides x

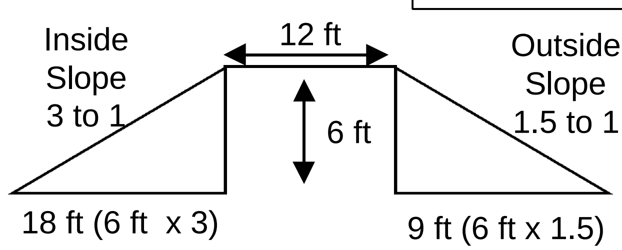
(540 ft + 500 ft) = 2080 ft

Width 12 ft

Calculation of the Dike Material Quantities

Description	No. Pcs.	Length (ft)	Width (ft)	Height (ft)	Quantity	Total Quantity
Excavation Dike						
Excav. Dike – Avg. 6' ht.	*1*	*2080*	*12*	*6*	*149,760 cf*	
Outside slope 1.5:1	*1/2*	*2080*	*9*	*6*	*56,160 cf*	
Inside slope 3:1	*1/2*	*2080*	*18*	*6*	*112,320 cf*	
				Total	*318,240 cf*	
					÷ 27	
					11,787 cy	
Bank Measure					*use*	*12,000*
Add 20% for Expansion					*2,357 cy*	*bcy*
					14,144 cy	
Loose Measure					*use*	
						14,200 lcy

10



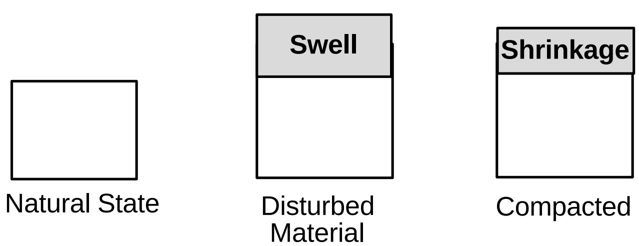
12,000 cy bank measure (bcy)

14,200 cy loose measure (lcy)

(20% Expansion factor)

Expansion:

Soil volume is defined according to its state in the earth-moving process. As earth is disturbed from its natural state, the material is broken up and air voids occur between the chunks and takeup additional space. This action is referred to as "material swell." The following figure represents how soil volume changes from natural state, disturbed, and compacted.



***Volume changes in soil*.**

Terminology used includes:

Bank cubic yard (bcy)—1 cubic yard of material as it lies in the natural state.

Loose cubic yard (lcy)—1 cubic yard of material after it has been disturbed.

Compacted cubic yard (ccy)—1 cubic yard of material after it has been compacted.

(Table on next page provides swell factors)

Notes / Discussion Points / Lessons Learned: ______________________________

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This table provides a list of common material and swell %.

	Approximate In-Bank Weight (lbs/cu. Bank Yd.)	Approximate In-Bank Percent Swell to Loose Measure	
Ashes (hard coal)	700-1000	7.5%	
Ashes (soft coal)	1080-1215	7.5%	
Bauxite	2700-4325	33.3%	
Clay, dry	2300	17.6%	
Clay, light	2800	25.0%	Use 20%
Clay, wet	3000	33.3%	
Coal, anthracite	2450	35.0%	
Coal, bituminous	2000	35.0%	
Coal, steam (compacted)	1890	39.0%	
Copper, ore	3800	35.0%	
Earth, dry	2700	25.0%	
Earth, moist	3000	25.0%	
Earth, wet	3370	17.6%	
Earth, with sand and gravel	3100	11.0%	
Gypsum	4300	75.0%	
Gravel, dry	3250	12.3%	
Gravel, wet	3600	13.6%	
Granite	4600	49.0 - 79.0%	
Iron ore, hematite	6500-8700	122.0%	
Limestone, blasted	4200	67.0 - 75.0%	
Loam	2700	21.5%	
Mud, dry	2160-2970	21.5%	
Mud, moderately packed	2970-3510	21.5%	
Rock and stone, crushed	3240-3920	35.0%	
Sand, dry	3050	12.3%	
Sand, wet	3500	15.0%	
Shale, soft rock	3000	66.7%	
Slate	4590-4860	66.7%	
Trap rock	5075	64.0%	

Source: International Harvester Company, *Basic Estimating* Third Edition

Notes / Discussion Points / Lessons Learned: ______________________________

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Estimate Development Phase

Step 4b: Labor Productivity

- **Labor hours can be calculated by:**
  - **Personal evaluation/assessment**
  - **Data sources**
  - **Crew-up estimate**

12

Discussion Leader/Facilitator Notes: The facilitator is to point out that multiple sources may be used to establish final labor hours and check one source against another. If you use worker assessment, you may want to check the reasonableness of it against industry published standards or, if you use publications, you may still want to get worker buy in.

Once the quantities are obtained, labor hours for accomplishing the work item must be calculated. Several sources and methods are used, including the following:

- Personal assessments and evaluation of time and resources required to accomplish a work item. Assessments can be obtained from:
  - workers
  - project team members
  - estimator's best professional judgment
- Data sources:
  - current or recent quotes
  - historical data (estimates or actual)
  - industry-accepted publications
  - product manufacturers (if applicable)
- Crew-Up Estimate:
  - This is an estimating method where the estimator establishes an installation rate by breaking the task into very small pieces and then developing what would be required to accomplish each small task. The addition of all the small tasks will equal the total installation hours.

Notes / Discussion Points / Lessons Learned: ______________________________

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Estimate Development Phase

Step 4b: Labor Productivity (continued)

- **Wage Rate Application**
  - **Identify Labor Rates**
  - **Identify and Apply Labor Burdens**
  - **Design Project-Specific Crew Mixes**

13

After labor hours are calculated, wage rates are applied based on resource type. Labor rates are obtained from the following sources:

1. The finance organization can usually assist in obtaining internal labor rates as well as overhead rates. These rates general already include labor burdens (benefits, leave, etc.)

2. Subcontractor rates are usually calculated as an average of historical subcontractor rates. Procurement personnel usually have access to such rate information. Estimating organizations will also maintain a library of rates as well as labor burdens.

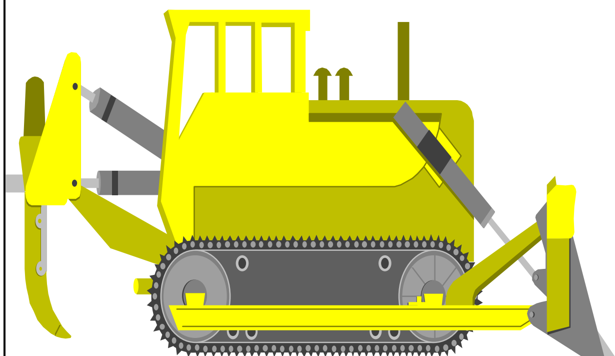
3. Estimating reference standards such as R.S. Means, Richardson, Environmental Cost Handling Options and Solutions (ECHOS) also can be a resource for labor rates and burdens, particularly for craft-type labor. Rates from these sources will have to be adjusted for location. Location indexes are typically included in this type of reference guide.

If labor hours were calculated as composite crews, crew rates should be calculated based on each crew make-up. Individual rates for calculating the composite crew rates can be obtained as discussed.

Notes / Discussion Points / Lessons Learned: ______________________________

Estimate Development Phase

Step 4c: Equipment Utilization



- **Identify equipment**
- **Develop cycle time and production**
- **Modify production**
- **Develop labor, material, and equipment costs**

14

- Identify the equipment required to perform the activity in the most cost-effective manner.
- Determine which piece of equipment is the actual “driver” for the activity in the equipment selection.
- Develop cycle time and productivity for the equipment.
- Modify production for special conditions (e.g., contamination level factors).
- Develop labor, material, and equipment costs.

Notes / Discussion Points / Lessons Learned: ______________________________

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Estimate Development Phase

Step 4d: Apply Pricing

- **Material Pricing Sources**
- **Current or Recent Vendor Quotes**
- **Historical Data**
- **Product Catalogs (when applicable)**
- **Industry Publications**
- **Estimator's Best Professional Judgment**
- **Procurement Personnel**
- **Subject Experts**

15

Material pricing can be obtained from several sources, including the following:

- Vendor quotes
- Historical data (estimate or actual)
- Product catalogs (when applicable)
- Industry-accepted publications and price catalogs
- Estimator's judgment
- Procurement personnel can also be a helpful resource
- Technical experts (i.e., an analytical chemistry department usually has industry information on laboratory analyses costs)

Notes / Discussion Points / Lessons Learned: ______________________________

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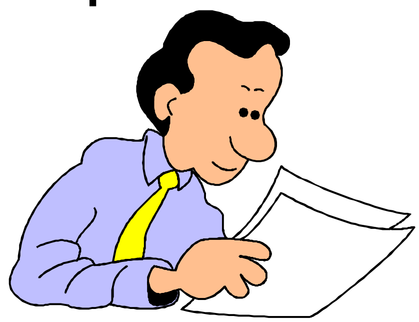
Estimate Development Phase

Steps 4b, 4c, and 4d:
Labor Productivity, Equipment Utilization, and Apply Pricing (continued)

- **How to Read a Industry Accepted Publication**



16

A couple of common industry-accepted publications for price and unit labor hours are:

- Environmental Cost Handling Options and Solutions (ECHOS)
- R.S. Means
- Richardson

Each of these publications has a little different format but provides similar types of information.

We will quickly look at ECHOS and explore some fundamentals.

Notes / Discussion Points / Lessons Learned: ______________________________

ENVIRONMENTAL RESTORATION

Unit Cost Book

1997

Senior Editor
Richard R. Rast

Technical Editor
Stephanie S. Klepacki

Contributing Editors
Jeannene D. Murphy
Jesse R. Page
Phillip R. Waier, PE

Manager, Engineering Operations
Patricia L. Jackson, PE

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Perry B. Sells

Vice President, Editorial Operations and Development
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Vice President, Sales and Marketing
John M. Shea

Vice President, Operations and CFO
Andrew J. Centauro

Production Manager
Karen L. O'Brien

Production Coordinator
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ECHOS

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COST HANDLING
OPTIONS AND
SOLUTIONS

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R.S. MEANS COMPANY, INC.
CONSTRUCTION
PUBLISHERS & CONSULTANTS
100 Construction Plaza, P.O. Box 800
Kingston, MA 02364-0800
(617) 585-7880

Delta Technologies Group, Inc.
7868 S. Hill Drive
Littleton, CO 80120

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The Environmental Restoration Unit Cost Book provides labor rates and pricing.

Notes / Discussion Points / Lessons Learned: ________________________________

ENVIRONMENTAL RESTORATION

Assemblies Cost Book

1997

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Richard R. Rast

Technical Editor
Stephanie S. Klepacki

Contributing Editors
Jeannene D. Murphy
Jesse R. Page
Phillip R. Waier, PE

Manager, Engineering Operations
Patricia L. Jackson, PE

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Karen L. O'Brien

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Kingston, MA 02364-0800
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The Environmental Restoration Assemblies Cost Book provides labor rates and pricing information for Environmental Restoration Assemblies.

Assemblies are composites of unit costs. Example: Concrete slab assembly would include a cost per square foot that would include formwork, rebar, embedments pouring, and finishing in one composite rate.

Notes / Discussion Points / Lessons Learned: ________________________________

Table of Contents

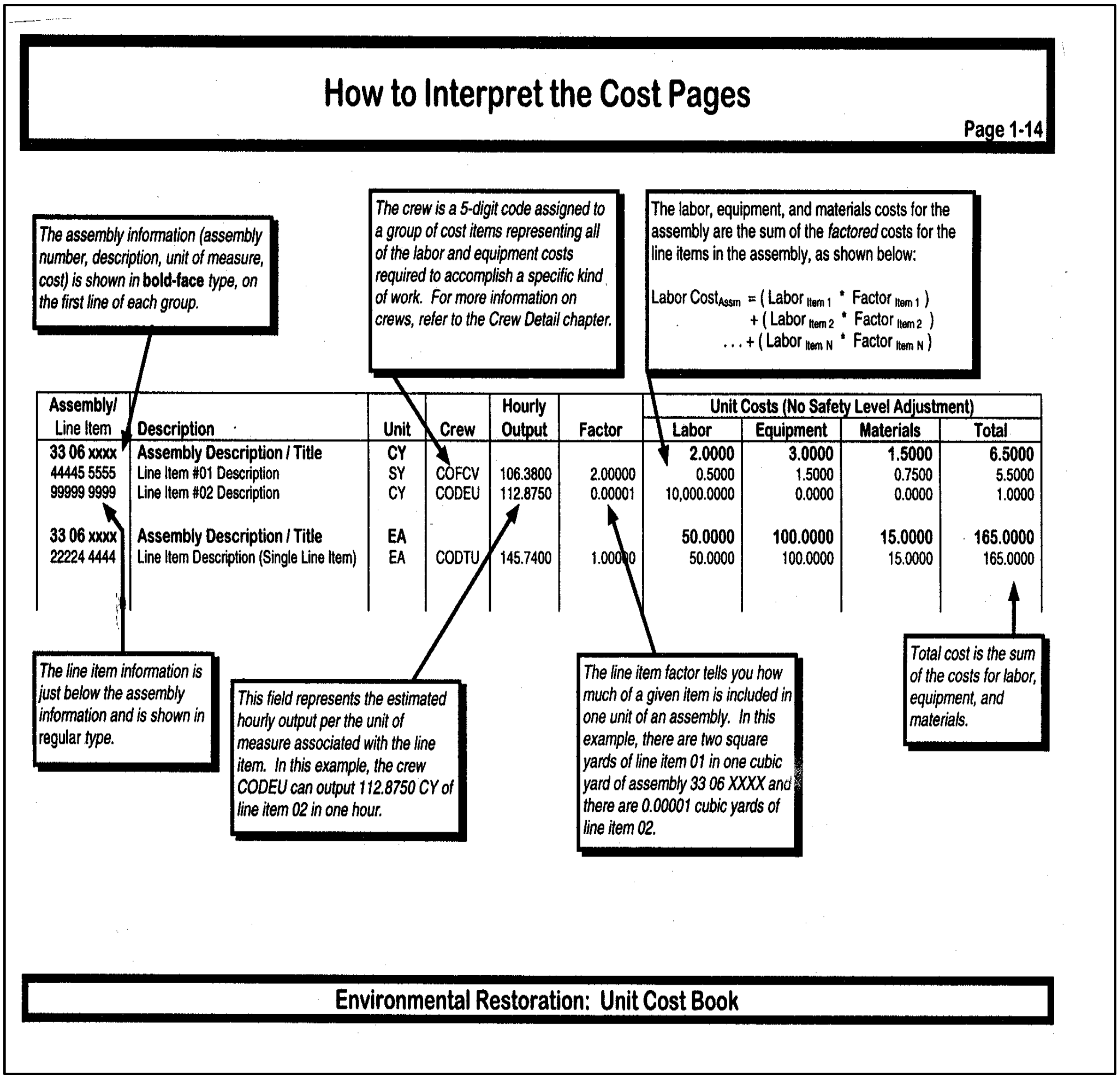
i

Environmental Restoration: Unit Cost Book

The table of contents provides a quick overview of the type of items included in the Unit Price Book.

Notes / Discussion Points / Lessons Learned: ____

Section 1.8: Cost-Estimate Process (Detailed Estimates)/Lessons Learned



How to Interpret the Cost Pages

Page 1-14

The assembly information (assembly number, description, unit of measure, cost) is shown in **bold-face** *type, on the first line of each group.*

The crew is a 5-digit code assigned to a group of cost items representing all of the labor and equipment costs required to accomplish a specific kind of work. For more information on crews, refer to the Crew Detail chapter.

The labor, equipment, and materials costs for the assembly are the sum of the *factored* costs for the line items in the assembly, as shown below:

$$\text{Labor Cost}_{Assm} = (\text{Labor}_{\text{Item }1} * \text{Factor}_{\text{Item }1}) + (\text{Labor}_{\text{Item }2} * \text{Factor}_{\text{Item }2}) \ldots + (\text{Labor}_{\text{Item }N} * \text{Factor}_{\text{Item }N})$$

Assembly/ Line Item	Description	Unit	Crew	Hourly Output	Factor	Unit Costs (No Safety Level Adjustment) Labor	Equipment	Materials	Total
33 06 xxxx	**Assembly Description / Title**	**CY**				**2.0000**	**3.0000**	**1.5000**	**6.5000**
44445 5555	Line Item #01 Description	SY	COFCV	106.3800	2.00000	0.5000	1.5000	0.7500	5.5000
99999 9999	Line Item #02 Description	CY	CODEU	112.8750	0.00001	10,000.0000	0.0000	0.0000	1.0000
33 06 xxxx	**Assembly Description / Title**	**EA**				**50.0000**	**100.0000**	**15.0000**	**165.0000**
22224 4444	Line Item Description (Single Line Item)	EA	CODTU	145.7400	1.00000	50.0000	100.0000	15.0000	165.0000

The line item information is just below the assembly information and is shown in regular type.

This field represents the estimated hourly output per the unit of measure associated with the line item. In this example, the crew CODEU can output 112.8750 CY of line item 02 in one hour.

The line item factor tells you how much of a given item is included in one unit of an assembly. In this example, there are two square yards of line item 01 in one cubic yard of assembly 33 06 XXXX and there are 0.00001 cubic yards of line item 02.

Total cost is the sum of the costs for labor, equipment, and materials.

Environmental Restoration: Unit Cost Book

Permission has been requested to reproduce this material.

Discussion Leader/Facilitator Notes: The facilitator is to review these columns with participants to describe information provided (if participants are familiar with this publication, the facilitator may not need to review this information in detail.)

Each publication usually has a front section that provides instruction on how to use and read the information. If you have not used the publication before, it is highly recommended that you look at this section. It is often easy to misunderstand and misuse the information if you are not familiar with it.

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 1.8: Cost-Estimate Process (Detailed Estimates)/Lessons Learned

16 01 Nonhazardous Selective Building Demolition

Page 3-1

Assembly/ Line Item	Description	Unit	Crew	Hourly Output	Factor	Unit Costs (No Safety Level Adjustment)			
						Labor	Equipment	Materials	Total
16 01 01	Substructure and Superstructure								
16 01 0102	**Remove Concrete Footing**	**CF**				**1.15**	**1.31**	**0.00**	**2.46**
02112 2003	Demolish Reinforced Concrete Building Foundation	CF	CLADD	84.3750	1.00000	1.15	1.31	0.00	2.46

Permission has been requested to reproduce this material.

Discussion Leader/Facilitator Notes: The facilitator is to walk through how to read the columns for the decommissioning example line item given.

An example of a line-item cost is the demolition of a reinforced concrete building foundation.

- The unit measure is in cubic feet (CF)
- The composite crew is CLADD (crew listings are in the front of the book in alphabetical order – see next slide)
- The composite crew can output 84.3750 CF of foundation demolition per work hour.
- Labor costs are $1.15/CF for the labor identified in the composite crew (4 semiskilled laborers, 1 foreman, and 1 equipment operator)
- Equipment costs are $1.31/CF for the equipment identified in the composite crew.
  - air compressor (375 cfm, 100 psi)
  - 2 paving breakers, 86 lb
  - front-end loader crawler 3.75 CF
  - small tools
  - 2 air hoses, 1 in. diameter, 100 ft long
- No material cost is associated with this slab demolition.
- The total labor and equipment cost is $2.46/CF of slab demolition.

Notes / Discussion Points / Lessons Learned: ________________________________

Crew Detail

Crew: CLADA

Quantity	Description of Labor/Equipment Item	Hourly Rate
0.5000	Air Compressor, 375 CFM, 100 PSI	14.25
1.0000	Paving Breaker, 86 LB (Add Compressor)	0.87
1.0000	Laborers, (Semi-Skilled)	15.36
0.2500	Laborers, (Semi-Skilled - Foreman)	15.97
0.5000	Equipment Operators, Light	19.61
0.1500	Small Tools	1.78
1.0000	Air Hose, 1.00", 100'	0.49
	Total Hourly Rate for Crew CLADA	$37.90

Crew: CLADB

Quantity	Description of Labor/Equipment Item	Hourly Rate
1.0000	Air Compressor, 375 CFM, 100 PSI	14.25
2.0000	Paving Breaker, 86 LB (Add Compressor)	0.87
4.0000	Laborers, (Semi-Skilled)	15.36
1.0000	Laborers, (Semi-Skilled - Foreman)	15.97
0.1900	Small Tools	1.78
2.0000	Air Hose, 1.00", 100'	0.49
	Total Hourly Rate for Crew CLADB	$94.68

Crew: CLADD

Quantity	Description of Labor/Equipment Item	Hourly Rate
1.0000	Air Compressor, 375 CFM, 100 PSI	14.25
2.0000	Paving Breaker, 86 LB (Add Compressor)	0.87
1.0000	Laborers, (Semi-Skilled - Foreman)	15.97
4.0000	Laborers, (Semi-Skilled)	15.36
1.0000	Equipment Operators, Medium	19.61
1.0000	Loader, Front End, Crawler, 3.75 CY	92.60
0.6100	Small Tools	1.78
2.0000	Air Hose, 1.00", 100'	0.49
	Total Hourly Rate for Crew CLADD	$207.64

Crew: CLADF

Quantity	Description of Labor/Equipment Item	Hourly Rate
2.0000	Laborers, (Semi-Skilled)	15.36
2.0000	Powdermen	14.31
0.2500	Powdermen (Foreman)	14.92
1.0000	Flatbed, 8'x 16.0' (Add Truck)	0.83
0.2500	Truck, Highway, 8,600GVW, 4x2, 3/4T-Pickup	8.42
1.0000	Truck, Highway, 24,500 GVW, 4x2, 2 Axle	17.99
	Total Hourly Rate for Crew CLADF	$84.00

Crew: CLADH

Quantity	Description of Labor/Equipment Item	Hourly Rate
1.0000	Air Compressor, 750 CFM, 100 PSI	27.92
0.5000	Laborers, (Semi-Skilled)	15.36
0.2500	Powdermen	14.92
1.5000	Equipment Operators, Medium	19.61
1.0000	Drill, Air Track, 2.5-4" Diameter, 12' FD	28.74
0.4600	Small Tools	1.78
0.2500	Truck, Highway, 8,600GVW, 4x2, 3/4T-Pickup	8.42
2.0000	Air Hose, 3.00", 100',	2.46
	Total Hourly Rate for Crew CLADH	$105.31

Environmental Restoration: Unit Cost Book

Permission has been requested to reproduce this material.

Discussion Leader/Facilitator Notes: Explain that this is what the page looks like. The next page has details of specific crew.

Crew listings are in the front of the book in alphabetical order.

Notes / Discussion Points / Lessons Learned: ________________________________

Crew: CLADD

Quantity	Description of Labor/Equipment Item	Hourly Rate
1.0000	Air Compressor, 375 CFM, 100 PSI	14.25
2.0000	Paving Breaker, 86 LB (Add Compressor)	0.87
1.0000	Laborers, (Semi-Skilled - Foreman)	15.97
4.0000	Laborers, (Semi-Skilled)	15.36
1.0000	Equipment Operators, Medium	19.61
1.0000	Loader, Front End, Crawler, 3.75 CY	92.60
0.6100	Small Tools	1.78
2.0000	Air Hose, 1.00", 100'	0.49
	Total Hourly Rate for Crew CLADD	**$207.64**

Our example of demolition of a reinforced concrete building foundation used a CLADD crew. This composite crew is made up of the listed workers and equipment. The composite hourly rate for this crew is calculated at $207.64.

Notes / Discussion Points / Lessons Learned:

The assembly and line item costs throughout this book are shown at Safety Level E (normal conditions). The costs for labor and equipment will typically be adjusted to account for the reduced productivity related to safety level requirements, as shown below:

Safety Level	Labor Productivity	Equipment Productivity
A	37% (typically 10-40%)	50%
B	48% (typically 25-60%)	60%
C	55% (typically 25-70%)	75%
D	82% (typically 50-90%)	100%

$$\text{Labor Cost}_P = \text{Labor Cost}_E \,/\, \text{Labor Productivity}_{P\;P}$$

$$\text{Equipment Cost}_P = \text{Equipment Cost}_E \,/\, \text{Equipment Productivity}_P$$

where $_P$ = Safety Level for the project

$_E$ = Safety Level E

Permission has been requested to reproduce this material.

Caution:

Be sure to know what is and is not included in the cost and productivity information, and adjust accordingly.

Above is an example of the impact to productivity as a result of safety level considerations. Higher level protection above Safety Level E would result in a decrease in productivity from rates provided in this book. An appropriate adjustment to the base rate would be required under a condition above Safety Level E.

Be sure to understand the base cost and know appropriate factors to include.

Example:

If one assumes a Safety Level C condition for the demolition of a reinforced concrete building foundation, the total cost would be calculated as follows: (Reference page 20 example)

Labor Cost = \$1.15/cf ÷ .55 =	\$2.09/cf
Equipment Cost = \$1.31/cf ÷ .75 =	\$1.75/cf
Material Cost =	\$ 0/cf
Total Cost =	\$3.84/cf for Safety Level C

Notes / Discussion Points / Lessons Learned: ______________________________

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Localization Information

Page 1-18

Alabama	
350	.84
351	.84
352	.84
354	.79
355	.77
356	.84
357	.83
358	.83
359	.82
360	.80
361	.80
362	.75
363	.80
364	.80
365	.85
366	.85
367	.80
368	.80
369	.80

Alaska	
995	1.29
996	1.29
997	1.28
998	1.28
999	1.33

Arizona	
850	0.91
852	0.86
853	0.91
855	0.90
856	0.90
857	0.90
859	0.90
860	0.92
863	0.89
864	0.89
865	0.89

Arkansas	
716	0.80
717	0.72
718	0.76
719	0.72
720	0.80
721	0.80
722	0.80
723	0.82
724	0.82
725	0.78
726	0.79
727	0.68

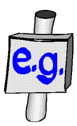
Arkansas (continued)	
728	0.77
729	0.80

California	
900	1.13
901	1.13
902	1.13
903	1.11
904	1.11
905	1.11
906	1.12
907	1.12
908	1.12
910	1.11
911	1.11
912	1.11
913	1.13
914	1.13
915	1.13
916	1.13
917	1.12
918	1.12
919	1.09
920	1.09
921	1.09
922	1.11

California (continued)	
923	1.09
924	1.09
925	1.12
926	1.11
927	1.11
928	1.12
930	1.12
931	1.11
932	1.08
933	1.08
934	1.12
935	1.09
936	1.11
937	1.11
938	1.11
939	1.14
940	1.26
941	1.26
942	1.13
943	1.19
944	1.19
945	1.18
946	1.20
947	1.34
948	1.19
949	1.21
950	1.17

Environmental Restoration: Unit Cost Book

Costs must also be adjusted for location. This is typical for almost all pricing books. The preceding table shows zip codes (the first 3 digits of the zip code) versus cost factors.



Example:
Assume we are in a location of zip code 90676 (the first 3 digits are used – 906)

The demolition of the reinforced concrete building foundation calculated on the previous page for $3.84/cf would be factored for location in area code 906 as follows:

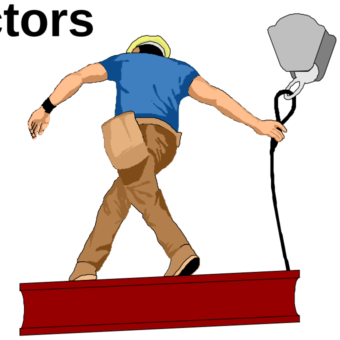
$3.84/cf x 1.12 = $4.30/cf

Notes / Discussion Points / Lessons Learned:

Estimate Development Phase

Step 5: Apply Job Factors

- **Labor hours, equipment hours, and pricing may need to be adjusted for consideration of job factors**



26

Job factors may be applicable to:

- Labor hours
- Equipment hours
- Pricing

Notes / Discussion Points / Lessons Learned: ____

Estimate Development Phase

Job Factors may include adjustments for:

- **Location**
- **Safety level/dressout**
- **Congestion**
- **Height**
- **Weather**
- **Union versus nonunion**
- **Security (working in a secure area)**
- **Escorts**
- **Confined space**

27

Discussion Leader/Facilitator's Notes: The facilitator should stress the importance of avoiding the duplication of factors.

Caution:

Be careful about adding factors on top of each other. Know your base, or you may adjust for a condition the base may already include. This is especially true of historical data. Subtracting factors may be appropriate and necessary to use historical data correctly.

Notes / Discussion Points / Lessons Learned: ______________________________

Estimate Development Phase

Mark-ups

- **Identify and Apply Cost Markups**
  - **General and Administrative (G&A) Overhead Rates**
  - **Subcontractor Overhead & Fee Markups**
  - **Estimated Insurance & Bond Costs**
  - **Prime Contractor Overhead and Fee Markups**

28

Cost estimate markups are applied to the appropriate contractor and subcontract costs for:

- General and Administrative (G&A) Overhead Rates
  These are overheads that include the subcontract cost of the general and administrative overhead. These are fixed costs in operation of a business. It is associated with office, plant, equipment, and staffing maintained by a contractor for general business and administrative operations. Administrative includes the salaries, travel, and other expenses for the overall administration personnel (i.e., executive salaries, financial personal, etc.). These rates are usually applied as percentage calculations.

- Subcontractor Overhead and Fee Markups
  These are the subcontractor overhead rates and fees. Fees are usually based on contractor risks. These rates are usually applied as percentage calculations.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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- Bonds are monetary securities that are generally provided by the bidder or contractor to assure the owner that the bidder or contractor will perform the required activities as agreed. The cost of bonds is generally paid by the bidder or contractor and must be included in the estimate. Typical construction bonds consist of bid bonds, performance bonds, and payment bonds, but may include other sureties as specifically required by the owner.

- Estimated Insurance and Bond Cost

  This is insurance, other than payroll, carried by the contractor in connection with the construction work (e.g., vehicle and property damage, liability, and builders risk).

- Prime Contractor Overhead and Fee Markups
  - The prime contractor will apply overhead and fee markup on top of his subcontractors costs.

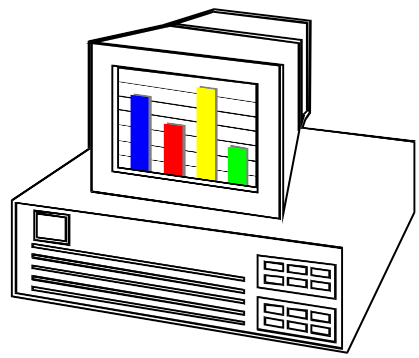
Note:
Ensure on all percentage-type overheads that the base to which the percentage is to be applied is correctly calculated. It is easy to inappropriately calculate overheads on top of each other or calculate off the wrong base costs.

Notes / Discussion Points / Lessons Learned:

Estimate Development Phase

Step 6A: Evaluate Resources, Schedule, and Spend Plan

Step 6B: Adjust



30

Once the hours and pricing have been calculated, the estimate must be evaluated to ensure that

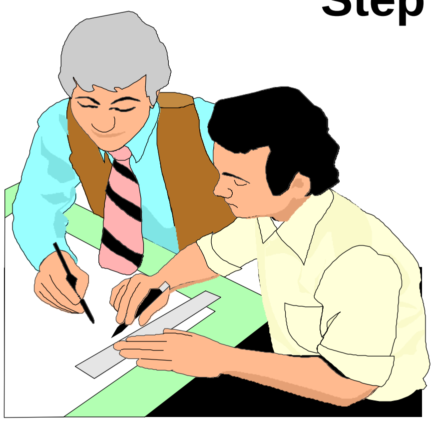
- Resource allocation over time is reasonable. (resource leveling)
  - Number of resources available
  - Space limitations (Can the resources physically fit in the work space?)
- The scheduled time periods are feasible and appropriate.
- Project estimated cost (spend plan) reasonably reflects funding available.

Adjust the estimate and schedule as necessary to achieve reasonable resource and spending plans.

Notes / Discussion Points / Lessons Learned: ____

Evaluation Phase

Step 7: Team Reviews and Checks



31

Discussion Leader/Facilitator Notes: Emphasize the importance of reviews.

Both project team and peer reviews are essential to development of a viable estimate. No matter how many years of experience or how good the estimator is, the estimator can easily get so close to the estimate that obvious items can be overlooked. An independent review is often necessary to see the obvious.

Notes / Discussion Points / Lessons Learned: ______________________________

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Evaluation Phase

Step 7: Team Reviews and Checks (continued)

- **Preliminary Summarization for Initial Reviews:**
  - **Costs Summarized and Separated by WBS**
  - **Time Phasing (Annual or Monthly Breakdown)**
  - **EXCLUDES Escalation and Contingency**

32

The preliminary summarization for initial reviews will require summarization and separation of costs by Work Breakdown Structure (WBS) and time phasing either annual or monthly. Initial reviews are usually done before incorporation of escalation and contingency.

Notes / Discussion Points / Lessons Learned: ______________________________

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Evaluation Phase

Step 8: Apply Escalation

- **Calculate and Apply Escalation Factor**
  - **Definition**
    - > **Provision for increases in cost of equipment, material, and labor overtime**
  - **Purpose**
    - > **Accurately estimate impact of inflation on out-year activities**

33

Discussion Leader/Facilitator Notes: Demonstrate how to apply escalation factors later on.

Office of Field Management (FM) publishes escalation rates, web address, and escalation table as shown below. The DOE project manager is responsible for and must be able to defend why particular rates were selected.

Escalation rates can be accessed on the web off of the FM-20 home page (http://www.fm.doe.gov/FM-20/).

The specific address for 1997 escalation is http://146.138.131.98/FM-20/escal97.html

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 1.8: Cost-Estimate Process (Detailed Estimates)/Lessons Learned

January 1997 Update

Departmental Price Change Index
FY 1999 Guidance
Anticipated Economic Escalation Rates
DOE Construction Projects

	Energy Research and Nuclear		Fossil		Conservation and Solar		Defense Programs and Gen. Const.		Environmental Restoration		Waste Management	
Fiscal Year	Index	%Change	Index	%Change	Index	%Change	Index	%Change	Index	%Change	Index	%Change
1997	.976	2.1	.976	1.9	.978	1.8	.978	2.6	.976	2.4	.980	1.9
1998	1.000	2.5	1.000	2.5	1.000	2.3	1.000	2.2	1.000	2.5	1.000	2.1
1999	1.028	2.8	1.028	2.8	1.027	2.7	1.024	2.4	1.028	2.8	1.026	2.6
2000	1.059	2.9	1.057	2.9	1.055	2.8	1.053	2.8	1.057	2.9	1.053	2.7
2001	1.090	2.9	1.087	2.8	1.084	2.7	1.081	2.7	1.089	3.0	1.082	2.8
2002	1.122	3.0	1.118	2.9	1.115	2.8	1.111	2.8	1.122	3.0	1.112	2.8
2003	1.158	3.2	1.153	3.1	1.148	3.0	1.142	2.8	1.156	3.0	1.144	2.9

Based on the materials and labor data contained in the Energy Supply Planning Model and appropriate escalation rates forecasted by Data Resources, Incorporated, it would be expected that DOE projects conform to those rates shown above. Guidelines for the implementation of DOE Order 430.1, "LIFE-CYCLE ASSET MANAGEMENT," recommend that any local rates different from those above be submitted to the Office of Project and Fixed Asset Management for approval, before their use. Additional advice and assistance can be obtained from the Associate Deputy Secretary for Field Management, Office of Project and Fixed Asset Management 202-586-9706.

Notes / Discussion Points / Lessons Learned: ______________________________

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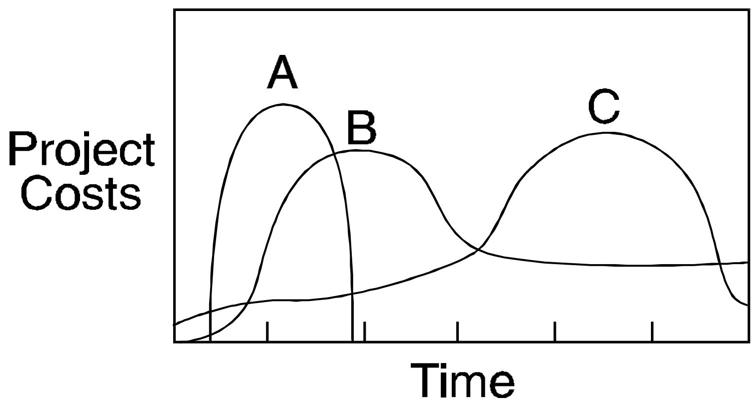
Evaluation Phase

Step 8: Apply Escalation (continued):

Escalation Factor



35

Discussion Leader/Facilitator Notes: We will demonstrate how to apply these escalation factors later. Most estimating software packages will calculate escalation given the rates and scheduled time periods that cost will be incurred; however, if one is using a spreadsheet or manual tools, escalation will need to be calculated. In the flowchart, escalation calculations are shown after team and peer reviews. Waiting to calculate escalation until after reviews will prevent having to recalculate (assuming that manual calculation is done).

Curve A:

- Escalation is dependent on length of schedule. The longer the schedule duration or the farther into the future that the work will be done, the higher the escalation value.
- All costs occur early in the project, so escalation will not be a major cost driver.

Curve B:

- A majority of the project's costs occur early in the project. However, the project lingers. Although the costs are relatively low later, it is still expensive to be incurring costs later in the project.

Curve C:

- Minimal costs are incurred early, and the majority of the costs are being incurred in the out-years, which has a tremendous impact on the total cost of the project because you are escalating large dollar values.

Note:
All the increased costs depicted on the graph may not be entirely due to the escalation factor.

Notes / Discussion Points / Lessons Learned: ______________________________

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Evaluation Phase

Steps in Calculating Escalation

- **Determine the midpoint of each activity from the schedule.**
- **Select appropriate DOE-HQ FY rates.**
- **Calculate the compound escalation rate from the base year to the midpoint of the activity.**
- **Apply the compound escalation rate.**

36

We will walk through a four-step process for calculating escalation.

Step A: Determine the midpoint of each activity from the schedule.

Step B: Select appropriate DOE-HQ FY rates.

Step C: Calculate the compound escalation rate from the base year to the midpoint of the activity.

Step D: Apply the compound escalation rate.

We will now take each step and show how to apply it.

Note:
This four-step method for calculating escalation can be found in the DOE G 430.1-1, *Cost Estimating Guide*.

Notes / Discussion Points / Lessons Learned: ________________________________

Evaluation Phase

Step 8: Apply Escalation (continued)

Escalation Example

37

Discussion Leader/Facilitator Notes: The facilitator is to walk through the example escalation calculation with the group. Structure questions to encourage participation.

Escalation calculation is performed for each component or activity in a project. Calculating escalation requires:

- Base year dollars in which the estimate was prepared
- Escalation rates
- Current performance schedule with activity start and completion dates

Remember:
A good WBS, in conjunction with good cost-estimating tools, can improve the accuracy in developing the escalation factors.

Example:
Calculating Escalation Factor
Determine base year—usually the estimate preparation date
Base year represents the time value of money in which the estimated costs were prepared (usually current dollars).

For our example, the base year is mid FY 98.

Notes / Discussion Points / Lessons Learned: ____________________

Step 8: (Continued) Escalation Example

Escalation Calculation — Step A

Scheduled Activity	WBS	Start	Complete	Duration Months	Midpoint
1. Pond Project Preliminary Design	A1A	02/01/98	10/01/98	8	06/01/98
2. Pond Project Detailed Design	A1B	11/01/98	04/01/99	5	01/15/99
3. Pond Project Construction	A1C	04/01/99	04/01/2001	24	04/01/2000

38

Calculation:

Escalation Step A:

Determine the midpoint of each activity from the start to the completion date.

Notes / Discussion Points / Lessons Learned:

Step 8: (Continued)
Escalation Example

Escalation Calculation — Step B

January 1997 Update

Departmental Price Change Index
FY 1999 Guidance
Anticipated Economic Escalation Rates
DOE Construction Projects

	Energy Research and Nuclear		Fossil		Conservation and Solar		Defense Programs and Gen. Const.		Environmental Restoration		Waste Management	
Fiscal Year	Index	%Change	Index	%Change	Index	%Change	Index	%Change	Index	%Change	Index	%Change
1997	.976	2.1	.976	1.9	.978	1.8	.978	2.6	.976	2.4	.980	1.9
1998	1.000	2.5	1.000	2.5	1.000	2.3	1.000	2.2	1.000	2.5	1.000	2.1
1999	1.028	2.8	1.028	2.8	1.027	2.7	1.024	2.4	1.028	2.8	1.026	2.6
2000	1.059	2.9	1.057	2.9	1.055	2.8	1.053	2.8	1.057	2.9	1.053	2.7
2001	1.090	2.9	1.087	2.8	1.084	2.7	1.081	2.7	1.089	3.0	1.082	2.8
2002	1.122	3.0	1.118	2.9	1.115	2.8	1.111	2.8	1.122	3.0	1.112	2.8
2003	1.158	3.2	1.153	3.1	1.148	3.0	1.142	2.8	1.156	3.0	1.144	2.9

Based on the materials and labor data contained in the Energy Supply Planning Model and appropriate escalation rates forecasted by Data Resources, Incorporated, it would be expected that DOE projects conform to those rates shown above. Guidelines for the implementation of DOE Order 430.1, "LIFE-CYCLE ASSET MANAGEMENT," recommend that any local rates different from those above be submitted to the Office of Project and Fixed Asset Management for approval before their use. Additional advice and assistance can be obtained from the Associate Deputy Secretary for Field Management, Office of Project and Fixed Asset Management 202-586-9706.

39

Calculation:

Escalation Step B:

Select appropriate DOE-HQ FY rates. Use rates for Environmental Restoration work.

Base year is mid FY 1998.

This can be accessed at the following Internet location:

http://146.138.131.98/FM-20/escal97.html

Notes / Discussion Points / Lessons Learned: ________________________________

Escalation Example

Escalation Calculations — Step C

	Base	Activity Midpoint	Compound rate
1. Preliminary Design	mid FY 98	06/01/98	1+(2/12 yrs x 2.5 %)=1.004
2. Detail Design	mid FY 98	01/15/99	[1 + (6/12 yrs x 2.5%)] x [1 + (3.5/12 yrs x 2.8%)] = 1.013 x 1.008 = 1.021
3. Construction	mid FY 98	04/01/2000	[1 + (6/12 yrs x 2.5%)] x [1 + (1 yr x 2.8%)] x [1 + (6/12 yr x 2.9 %)] = 1.013 x 1.028 x 1.0145 = 1.056

40

Calculation:

Escalation Step C: Calculate the compound escalation rate from the base year. This calculation is shown in the table composite rate from the base year for each activity.

Note:

Because compound rates are an increase to base multiplied, a 1 is added to factors before multiplying. Remember: a 2.5% increase is calculated by multiplying by 1.025.

- The Pond Project preliminary design midpoint in Step A was calculated to be June 1, 1998. Because the base year is mid FY 98, this cost is escalated only from the end of March 1998 (mid FY 98) to May 1, 1998 (2 months) to the compound rate; therefore, 2 months or 2/12 x 2.5% escalation "% change" for 1998 (Environmental Restoration).

- The Pond Project detail design midpoint in Step A was calculated to be January 15, 1999. The compound rate from base year mid FY 98 to January 15, 1999 is 6 months in FY 98 x 2.5% escalation "% changes" for 1998 and 3.5 months in FY 99 3.5/12 of a year x 2.8% escalation "% change" for 1999 (Environmental Restoration).

- The Pond Project construction midpoint in Step A was calculated to be April 1, 2000. The compound rate from base year mid FY 98 to April 1, 2000 is 6 months in FY 98, 1 year in FY 99, and 6 months in FY 2000. Each of these is multiplied by the respective rates of 2.5%, 2.8%, and 2.9% escalation "% change" (Environmental Restoration).

Notes / Discussion Points / Lessons Learned: ______________________________

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Step 8: (Continued) Escalation Example

Escalation Calculation — Step D

Pond Project Activity	Activity Cost	Compound Escalation Rate	Activity Cost Escalated
1. Preliminary Design	$150,000	1.004	$150,600
2. Detail Design	$400,000	1.021	$408,442
3. Construction	$2,000,000	1.056	$2,112,000

41

Calculation:

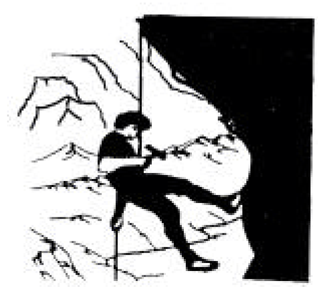
Escalation Step D:

- The Pond Project preliminary design cost is estimated at $150,000 in mid FY 98 dollars. The compound escalation rate to activity midpoint was calculated to be 1.004. The activity escalated costs is $150,000 x 1.004 = $150,600.
- The Pond Project detail design cost is estimated at $400,000 in mid FY 98 dollars. The compound escalation rate to the activity midpoint of January 15, 1999 was calculated to be 1.021. The activity escalated cost is $400,000 x 1.021 = $408,442.
- The Pond Project construction is estimated to cost $2,000,000 in mid FY 98 dollars. The compound escalation rate to the activity midpoint of April 1, 2000 was calculated to be 1.056. The activity escalated cost is $2,000,000 x 1.056 = $2,112,000.

Notes / Discussion Points / Lessons Learned: ______________________

Evaluation Phase

Step 9a and b: Analyze Risk and Apply Contingency



PROJECT RISKS MUST BE IDENTIFIED

42

The following topics related to contingency will be covered in the following slides.

- Definition
- Key elements in evaluating contingency
- Factors affecting contingency
- Relative contingency approximation
- Contingency development tools
- Contingency versus management reserve

Notes / Discussion Points / Lessons Learned: ______________________________

Evaluation Phase

Step 9a and b: Analyze Risk and Apply Contingency (continued)

- **Definition:**
  - **Amount budgeted to cover costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties that affect cost and time**
  - **Not intended to cover changes to the scope of the work or standards for performance**
  - **Calculated based on a documented risk assessment**
  - **Controlled by DOE**

43

- Contingency is an integral part of the cost estimate. Contingency is particularly important where previous estimate and actual cost experience has shown that unforeseeable events that will increase costs probably will occur.

- Contingency is not to be used to avoid making an accurate assessment of expected cost. It is not DOE practice to set aside contingency for major schedule changes or design factors, unanticipated regulatory standards or changes, incomplete or additions to project scope definition, or Congressional budget cuts. Changes to the scope of work or standards of performance are typically addressed through the baseline change-control process.

- Contingency is managed—approval for use is required before use. Contingency is not a project slush fund. DOE controls contingency until the specific unknown event happens. Contingency usage is monitored, tracked, and reported monthly.

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

- As project performance and events become more predictable,
  - Contingency may decrease and
  - Contingency analysis at individual WBS elements is possible

- Performing a risk analysis and assessment is critical:
  - Identify events/conditions that could affect the project
  - Evaluate the probability of each event
  - Evaluate the amount at stake
  - Calculate the expected value of the event

- Risk analysis drives contingency. A written contingency analysis must be performed on all cost estimates.

- Contingency analysis is performed by activity; however, contingency is a single fund for the project and is not tied to any single activity.

Notes / Discussion Points / Lessons Learned: ______________________________

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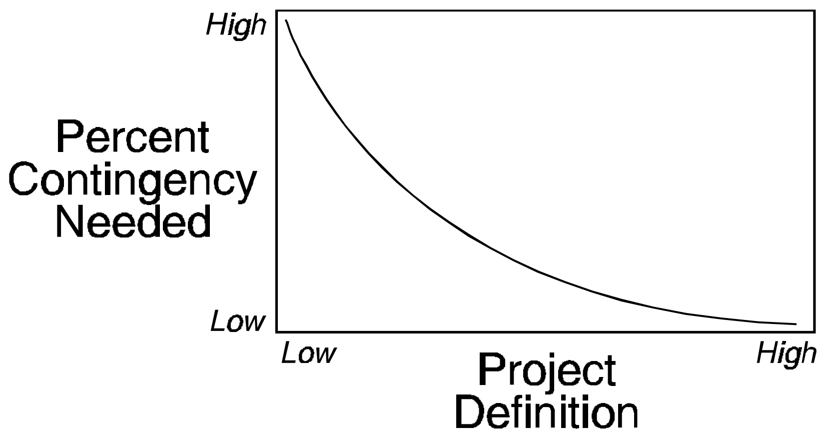
Step 9a and b: (Continued) Evaluation Phase

Relative Contingency Approximation



45

- Past experience on similar projects can help with risk identification.
- Estimators may use ranges DOE-provided for estimating contingency for small projects; however, larger projects require a detailed analysis, including a cost-estimate basis and a written description for each contingency allowance assigned to the various points of the estimate.
- See Appendix D for DOE-provided Contingency Ranges.
- As the project progresses, the project definition improves, so the amount of contingency needed decreases. In addition, as the project progresses, less work must be completed, also lowering the necessary contingency.
- Note that for lower-cost projects, the contingency percentage might need to be increased to provide an adequate and reasonable amount of contingency dollars. For instance, if you have a $10,000 project with 10% contingency, only $1,000 is available for contingency. However, if you have a $1 million project with 10% contingency, $100,000 is available.
- The contingency dollars should be based on an assessment of the risks and expected value of events.

Notes / Discussion Points / Lessons Learned: ____________________

Step 9a and b: (Continued) Evaluation Phase

Review of Typical Risks to DOE Projects

- **Specific risks typical to DOE projects include:**
  - **Technology, complexity, and quality**
  - **Stakeholders and other participants**
  - **Funding**

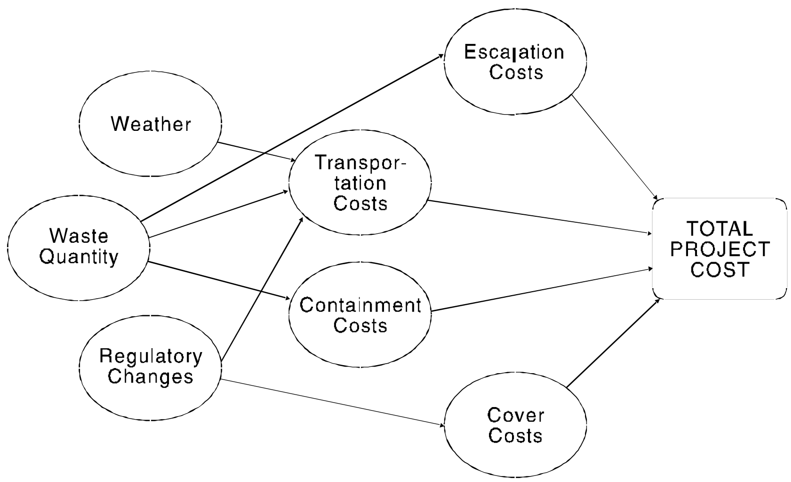
46

- See Appendixes E and F for supplemental information on typical project risks that should be considered.
- In many projects, funding is a risk but contingency is not applied, so this is not normally a cost-estimating issue.
- Conducting a project risk assessment is typically covered extensively in a project planning course.
- Methods of categorizing project risks:
  - There are many methods of categorizing project risks. Methods tend to be specific to the particular industry and its operating environment.
  - The management approach can be adapted to a variety of industries and environments. Risk management approaches generally emphasize identifying sources of risk and planning to mitigate their potential effect.
- Sources of risk can be grouped into five major categories:
  - External unpredictable (e.g., natural hazards),
  - External predictable but uncertain (e.g., inflation),
  - Internal nontechnical (e.g., schedule delays caused by labor shortage),
  - Technical (risks specific to creating/operating a particular technology), and
  - Legal (e.g., contractual failure).

Notes / Discussion Points / Lessons Learned: ______________________________

Step 9a and b: (Continued) Evaluation Phase

Risk Identification



47

Discussion Leader/Facilitator Notes: Not all costs affect all activities. This slide is simply an example and does not attempt to identify all potential risks. Identifying and documenting risks are very important steps in the cost-estimate development process. Early identification of risks can help minimize the impact on total project cost.

The influence diagram above is just one way to trace the potential impacts of a project risk. Inclement weather, for example, will not only cause delays in excavating dirt but also create transportation difficulties. Both of these events can lead to increased costs.

Notes / Discussion Points / Lessons Learned: ______________________________

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Step 9a and b: (Continued) Evaluation Phase

Key Elements in Evaluating Contingency

- **Should be based on an activity-by-activity risk analysis**
- **Should decrease as the project is executed**
- **Total contingency dollars should be adequate and reasonable**

48

As the project progresses, the scope and events become better defined.

For small, well-defined projects with little risk, a blanket percentage for contingency can be used.

Inappropriate uses of contingency:

- Not to be used for unauthorized technical baseline changes
- Contingency should not be spent just to use it up

Appropriate uses of contingency:

- Incomplete designs and revisions
- Technological change (not scope)
- Omissions
- Unknowns in projects
- Incorrect assumptions
- Regulatory changes
- Abnormal construction and start-up problems
- Construction disturbances
- Changes in market conditions and inflation
- Estimating inaccuracy
- Escalation rate variations; and
- Unforeseen safety requirements

Notes / Discussion Points / Lessons Learned: ______________________________

Review Processes

Step 10: Present and Defend

- **Estimate Review and Buy-in by:**
  - **Project Team**
  - **Customer**

49

The final estimate requires review and buy-in (recommend sign-off) by the project team and the customer.

Notes / Discussion Points / Lessons Learned: ____

Review Processes

Step 10: Present and Defend (continued):

- **Estimate Package (scope, schedule, cost estimate) assumptions, basis clearly defined, and documented**
- **Report formats**
- **Summary reports**
- **Spend plans**
- **Back-up supporting information**

50

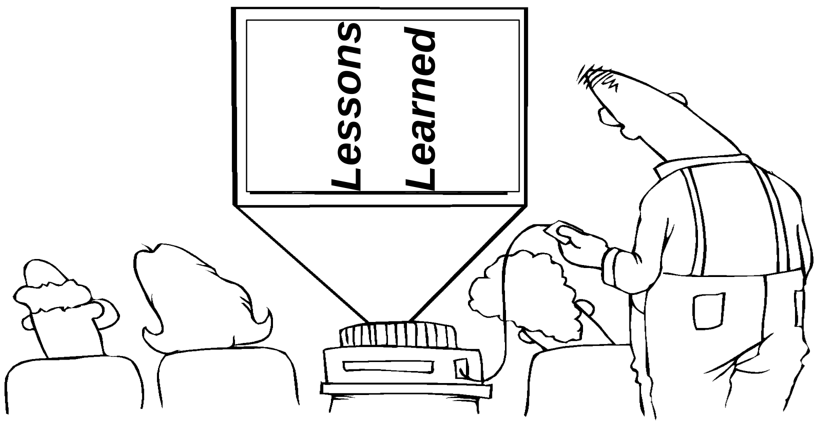
Discussion Leader/Facilitator Notes: Section 1.9 will discuss this step in detail and define the contents of the estimate package.

The estimate package must be a completed documented package that includes scope, schedule, and cost-estimate details. It must clearly explain assumptions and the basis for the calculations and estimate.

Report presentation must be such that information is meaningfully summarized and represented.

Notes / Discussion Points / Lessons Learned: ______________________________

Lessons Learned



51

1. Is it always clearly defined where inputs for definition of cost escalation is generated?

   Is there a standard process/procedure for its development?

   How do you establish confidence in the values?

   How do you get management to accept your data?

   How does management use your information?

   In what ways can all this be improved?

2. What is the philosophy of contingency?

   Are you always allowed by management to evaluate what could go wrong and define your fall-back position estimate?

   Does management have the philosophy that no problems will ever occur?

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ______________________________

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3. How are contingency and management reserves addressed?

   How do you define each term within your estimate?

   How is each communicated to the project manager and other superiors?

   How does the use of either affect the evaluation of the validity of your estimate against actual project costs?

   How do you ensure it is identified only once in your estimate information?

4. How do you document where you obtained your price input?

   What should be done to ensure higher quality in these data?

5. How does HTRW relate to the assembled estimate book?

   Are there any concerns that these factors may not agree?

6. What care should be taken in adding factors on top of each other?

   How is this ensured?

   What could be done to improve it?

7. Misapplying overhead rates and markups is fairly easy to do. What controls do you have to ensure that it doesn't occur?

   How could it be improved?

8. What has been the success of the team review in finding errors or omissions in the estimates?

9. Is it a good idea to exclude escalation and contingency?

   What could be gained if they were included?

   How would it be done?

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ____________________________________

10. Who manages contingency when is it used, and how is the decision made to use it?

    How much input is given to define contingency?

    How much should there be?

    How is the input documented where it is used?

11. How much emphasis is placed on producing a written contingency analysis?

    What level of risk analysis is applied?

    What improvements of these areas should be made?

12. Who defines the expected value of events?

    What is used for support data?

    Who reviews all of these data for accuracy?

13. How supportive is the risk analysis report for the project?

    What could be done to improve it?

14. As the project moves out, how are new potential risks identified and incorporated into the estimate?

    What could be done to improve this?

15. Appropriate uses of contingency are important. A few of those are incomplete designs and revisions, technological change (not scope), omissions, unknowns in projects, incorrect assumptions, regulatory changes, abnormal construction and start-up problems, construction disturbances, changes in market conditions and inflation, estimating inaccuracy, escalation rate variations, and unforeseen safety requirements.

    What others should be considered?

    Do you know of situations relative to any of these uses that really affect the cost estimate?

    What can be done to correct this?

(Continued on next page)

Notes / Discussion Points / Lessons Learned: ____________________________________

16. Who publishes and approves the cost-estimate package?

    Who maintains change control to it?

    What problems have you experienced in trying to defend the package?

    How often is your input not used?

    How can you improve this system?

17. How often does management tell you what a cost estimate should be well before you finish the estimate?

    Have you ever been forced to make your numbers conform to a preselected management value?

    What can be done to prevent this situation?

Notes / Discussion Points / Lessons Learned: ______________________________

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Section 1.9

Documentation Provided in Cost Estimate/ Lessons Learned

1

Discussion Leader/Facilitator Notes: Emphasize the importance of complete, written, traceable assumptions and documentation. The estimator should not assume that someone else will understand what they were assuming or the basis of the calculations. Documentation and stating assumptions are important elements of a cost estimate. Without them, the estimate cannot be defended or substantiated.

This section will discuss the quality and contents of a cost-estimating package (as defined by DOE G 430.1-1, *Cost Estimating Guide*). The format and presentation of cost estimates will not be specifically addressed. These are generally considered site-specific preferences.

Lack of documentation or incomplete estimate backup provides many lessons learned.

Notes / Discussion Points / Lessons Learned: ______________________________________

Project Cost-Estimate Summary

Date:

Rev. #:

1. -----	**$**
2. -----	**$**
3. -----	**$**
4. -----	**$**
5. -----	**$**
Subtotal	**$**
Contingency	**$**
Escalation	**$**
Net Present Value	**$**

2

Discussion Leader/Facilitator Notes: Obviously, most of the items identified as estimate documents would be part of the estimate package; however, as with most documentation, we typically do not do as complete a job as we should. Most estimate packages will lack many of the items discussed in this section.

- A cost-estimate summary provides an overview of the total cost estimate. Generally, this summary lists estimate items by WBS.

- This is a sample format that will vary from site to site.

Notes / Discussion Points / Lessons Learned: ______________________________

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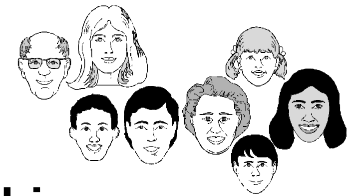
Document Ownership



- **Define estimate ownership (project manager/project team)**
- **Summary of estimate use, purpose, type, etc. (executive summary)**

3

This information is usually provided in a cover memorandum or estimate cover sheet that will:

- Define who is responsible for this estimate (including signatures), and
- Summarize what the estimate is (e.g., intended use, estimate purpose, and type).

This information provides the basis for estimate confidence.

Notes / Discussion Points / Lessons Learned: ______________________________

Section 1.9: Documentation Provided in Cost Estimate/Lessons Learned

Scope

Provide a statement identifying the estimate type, project scope, and project objective.

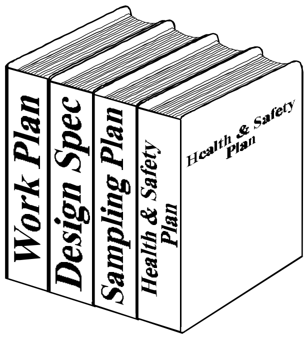
4

- The technical scope should include all requirements for the project or program.
- The technical scope description should define the work to be performed and work not included in the scope of the estimate.
- A detailed description of the technical scope of work should be included for a detailed estimate. It should define any performance requirements and the work activities required and any constraints or special conditions, rules, assumptions, and regulatory drivers.
- Identification of the estimate type will provide both an understanding of the completeness of project definition and an estimate accuracy range.
- The statement of the project objective should be clearly defined to ensure that the assumptions made and the work processes defined support the project objective.

Notes / Discussion Points / Lessons Learned: ____________________

Source Documents

Identify all PROJECT-SPECIFIC documents used to develop the estimate.



5

- All source documents used to provide the project definition should be identified.
- Dates and revision numbers should be included because newer documents can affect or change project scope definitions.
- Examples of source documents include the following:
  - Statement of Work in a Request for Proposal (RFP)
  - Work Plan
  - Design documents or drawings
  - Sampling Plan
  - Health and Safety Plan

Notes / Discussion Points / Lessons Learned: ______________________________

Work Breakdown Structure

Attach the Work Breakdown Structure (WBS) used in preparing the estimate.

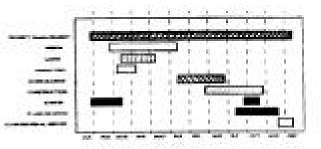
(If other or additional structures were used to summarize the estimate, identify how the estimate was categorized, sorted, and sequentially separated.)

6

- An outline of the Project Work Breakdown Structure (WBS) will help one understand how the estimate is organized.
- The project WBS helps provide project definition by defining project work elements.
- If an activity dictionary exists, inclusion or reference to this document will provide further definition and understanding of project scope.

Notes / Discussion Points / Lessons Learned: ______________________________

Schedule



Provide the schedule report on which the estimate was based

- **Milestone log**
- **Schedule drivers (regulatory commitments)**
- **Special considerations**

7

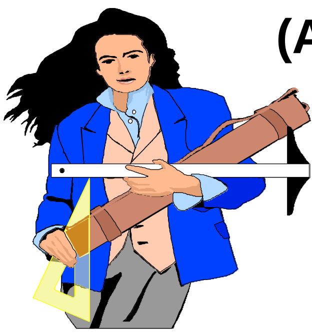
Discussion Leader/Facilitator Notes: An estimate cannot be developed without consideration of scheduled durations and time periods. Many costs are related to time durations (e.g., how long the item is needed).

- The schedule is an important part of the cost-estimating package.
- It identifies
  - The basis for budget-cycle timing
  - Any premiums on long lead items to ensure their timely delivery
  - The basis for escalation
  - Spend plans (a plan that shows how costs will be spent over the scheduled project life. If the schedule is resource loaded with cost, a spend plan can be generated as a schedule report.)
  - Resource loading over project duration
- Scheduling and cost estimating is an iterative process and will vary from field office to field office and organization to organization.

Notes / Discussion Points / Lessons Learned: ______________________________

Cost Estimate Quantity Survey

State WHO performed the quantity surveys, and identify any performance or Quantity Survey (QS) consistency checks used on larger projects.



(Always attach a copy of the summary of quantities to the estimate.)

8

Discussion Leader/Facilitator Notes: Detail quantity takeoffs from design drawings are often generated by computer-aided design software.

- The cost estimate or its backup should clearly identify how the following quantities were derived:
  - Quantity takeoffs
  - Calculations
  - Comparison with other projects/past experience
  - Documents (Sampling Plan, Work Plan, etc.)
  - Expert opinion
- Where appropriate, identify personnel providing the information and performing quantity takeoff and the data validator.
- Calculations should be shown.

Notes / Discussion Points / Lessons Learned: ____

Units of Measure

Identify units of measure and acronyms

9

Discussion Leader/Facilitator Notes: Units of measure (UM) and acronyms often seem obvious, but what is obvious to one person may not be obvious to everyone.

- Always identify units of measure.
- Be consistent in the use of acronyms.
- Use the units of measure specified in your cost structure (e.g., HTRW). Also, use units specified at the outset by the project manager.

Notes / Discussion Points / Lessons Learned: ______________________________

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Labor Productivity

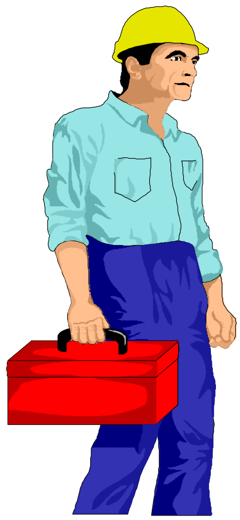
Identify sources and factors used to develop productivity factors.

10

- Labor productivity factors and assumptions will often include such considerations as
  - Height
  - Location
  - Union versus nonunion labor
  - Dressout/level of protection
  - Craft skill level
  - Uniqueness and complexity of work
  - Congestion
  - Heat
  - Weather
  - Other unusual work conditions
  - Hazards
  - Safety levels
  - Security

Notes / Discussion Points / Lessons Learned: ______________________________

Labor Rates



State the source of labor rates and burden factors.

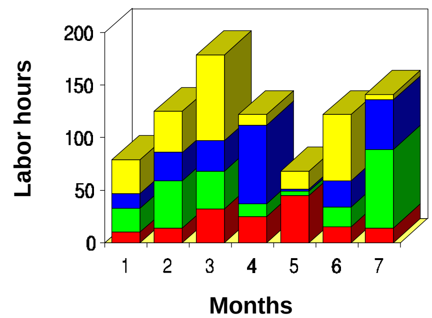
11

- Provide the source of labor rates.
  - Union versus nonunion
  - David Bacon
  - Site stabilization
  - Contracting strategy
- Explain the labor overheads (burden).
- Labor rates may need to be a dated list of site cost center rates and overheads.

Notes / Discussion Points / Lessons Learned: __________________________________

Work Resources

Identify resource loading that will be required to perform work on the project.

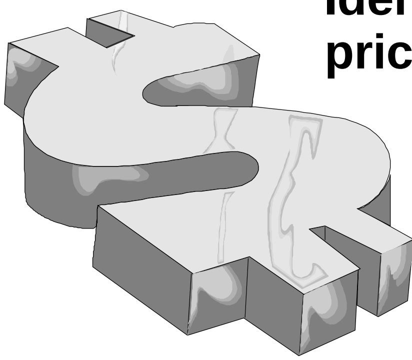


12

Required resources over time should be identified and included as part of the estimate package.

Notes / Discussion Points / Lessons Learned: ____

Material Pricing Basis and Source



Identify the source and/or price development for the majority of prices.

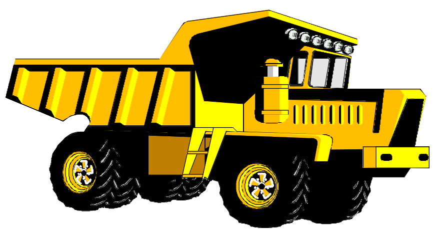
13

- The cost estimate or the back-up material should include pricing sources and calculations and should identify the following:
  - Pricing catalogs (dates of publication)
  - Data bases
  - Historical data
  - Calculated Cost-Estimating Relationships (CERs)
  - Vendor quotes (the date the quote was provided)
  - Cost-estimating systems/models
- Taxes, shipping costs, and other material markups should be clearly identifiable in the estimate package.

Notes / Discussion Points / Lessons Learned: ____________________

Equipment

State the basis for development of equipment costs.



(Labor-hour based or "rental store" based?)

14

The cost estimate should clearly state or show equipment-use calculations or assumptions. Equipment may include the following:

- Construction equipment
- Sampling equipment
- Field office equipment

Equipment may be rented or purchased.

Identify equipment that may be available for use that was purchased by the site or a previous project.

Notes / Discussion Points / Lessons Learned: ______________________________

Other Considerations

- **Field Distributables**
- **Site Overhead**
- **Operating Costs**
- **Cost Markups**

15

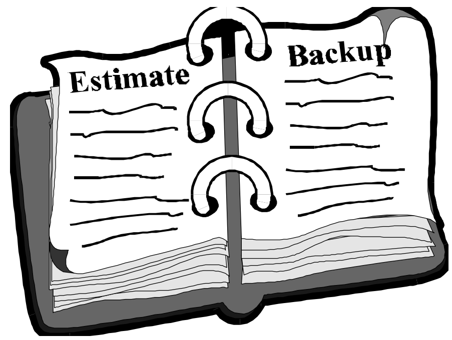
- Field-distributable overheads should be in enough detail to describe what is included (e.g., site security, on-site trailers, and health and safety).
- Provide an explanation of site overhead rates.
- Provide project back-up supporting information.
- Identify applied cost markups:
  - G&A overhead rates,
  - Subcontractor overhead and fee,
  - Estimated insurance and bond costs, and
  - Prime contractor overhead and fee.

Notes / Discussion Points / Lessons Learned: ______________________________

Section 1.9: Documentation Provided in Cost Estimate/Lessons Learned

Estimator's Assumptions

The cost estimator must document in writing the assumptions and exclusions used in the estimate.



16

One of the most critical items in support of a quality cost-estimate package is accurate and complete definition/documentation of all assumptions used in the generation of each part of the estimate package. These assumptions should be clearly visible and traceable to their respective supporting data. Project-level assumptions should be provided in the final summary of the package and should be provided in all communications where the cost estimate is identified.

Notes / Discussion Points / Lessons Learned: ______________________________

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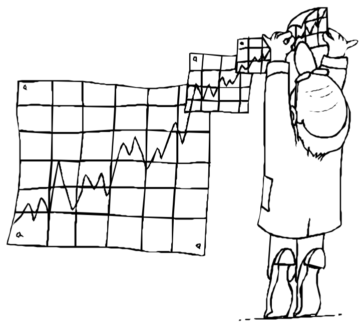
Escalations

Identify all types of escalation factors used, the sources for the factors, and how the factors were applied.



17

- The escalation calculation should be clearly identified and traceable.
- Most estimated projects are estimated in current year dollars and escalated to the year in which the work will be accomplished.
- If an estimate is prepared using an estimating software package, escalation calculations may be automated; otherwise, the escalation calculation should be included in the estimate backup.
- The date of the DOE-published escalation rates used should be referenced or stated in the estimate documentation.

Notes / Discussion Points / Lessons Learned: ______________________________

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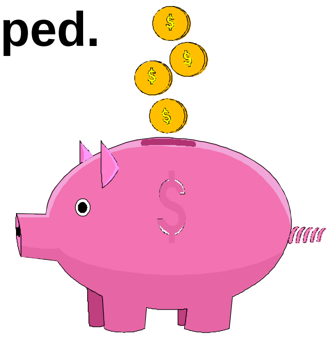
Risk Analysis/Contingency

Identify and illustrate how project contingency was developed.

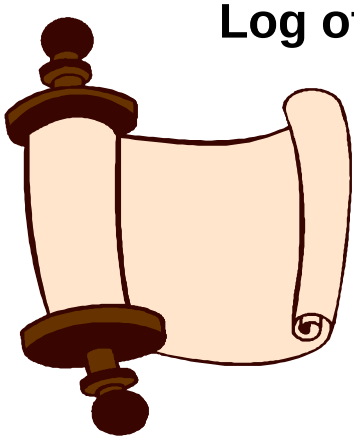


18

- A written analysis of how project contingency was developed should be provided in the cost-estimating package.
- Contingency should include cost and schedule contingency.
- Explain items of significant risk that were discovered either in developing the estimate or in performing a formal risk analysis.

Notes / Discussion Points / Lessons Learned: ____

Estimate History



Log of estimate revisions.

- **Identify the name, signature, and/or initials of the preparer(s) and reviewer(s).**

19

Discussion Leader/Facilitator Notes: Identification of the reviewer(s) is extremely important and often relates directly to the credibility of the estimate.

- If the estimate is a revision of an existing estimate or a change-order estimate, the estimate history should be provided.
- The estimate package should include the name, signature, and/or initials of the preparer(s) and all reviewer(s) of the estimate.
- Document the reconciliation between estimated revisions.

Notes / Discussion Points / Lessons Learned: ______________________________

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Attachments/References

Use as many attachments and references as necessary to communicate to the reviewer the estimate development, confidence, and clarity.

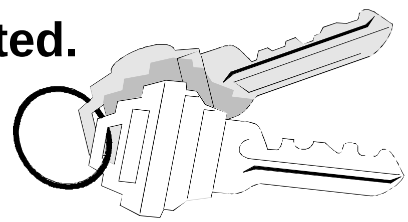
20

The estimate package should include as many attachments and references as necessary to communicate and document clearly how the estimate was developed.

Notes / Discussion Points / Lessons Learned: ______

Remember

The estimate package is <u>the only</u> key to understanding HOW, WHAT, and WHY costs were estimated.



21

Discussion Leader/Facilitator Notes: An estimate package rarely provides too much detail. Typically reviewers or users of the estimate spend considerable time trying to guess or figure out why or how something was calculated.

- A defensible, well-documented cost-estimating package withstands scrutiny.
- If rigorous documentation and estimation procedures are followed, the credibility of the estimate increases.
- It is important to document all steps of the estimate process.
- Do not assume that assumptions are obvious.

Notes / Discussion Points / Lessons Learned: ______________________________

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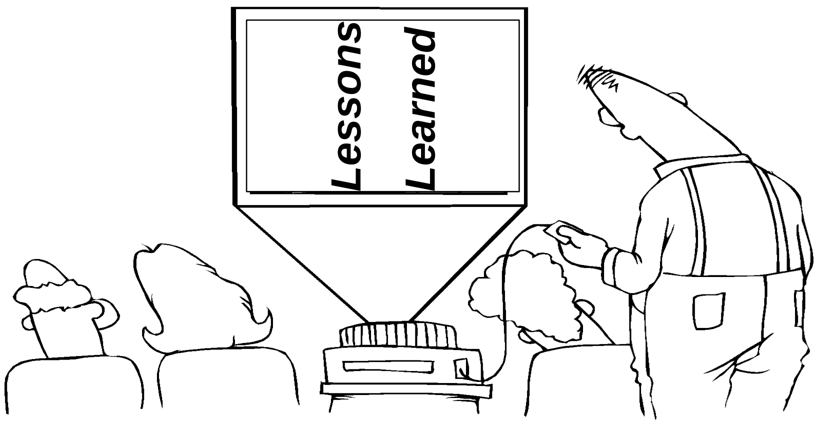
Lessons Learned



22

1. What problems have you experienced in ensuring that assumptions always remain traceable and are accurately defined?

   What requirements are defined in the Project Management Plan or guidance to establish this as a requirement?

2. How have assumptions been misused by others?

   How can this misuse be alleviated?

3. What ensures that each component of the cost estimate is accurate?

   Would a cover sheet with signatures supporting accuracy/validity on each portion supporting the package be a solution?

4. Should a checklist for the package be used to ensure that all data are included in the package?

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Notes / Discussion Points / Lessons Learned: ________________________________

5. Who has ownership of the completed package?

   What establishes that ownership?

   Does this ownership include the responsibility for change control?

6. What is used to ensure that all revisions to the estimate are accurate and included in the package?

   How do you ensure that the correct revision of the support document is used and documented?

7. What errors have you experienced from how the estimate was organized?

   Is it essential that a WBS always be used?

   What assurance exists that all of the work elements within a WBS are included and properly defined and understood?

8. Schedule drivers are important to identify and sequence within the project life. How do you ensure that all drivers are identified?

   What about assumptions associated with each?

   How do you ensure that each driver on a project or activity is positioned at the proper schedule location so that the intended impact or influence is accurate?

   The National Environmental Policy Act of 1969 (NEPA) might be a good example under this consideration.

9. What do you consider to be “special considerations” in schedule estimating?

   How should they be used and treated?

   Are they used properly?

   Have you ever experienced misuse, and how was this problem corrected?

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Notes / Discussion Points / Lessons Learned: ______________________________

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10. How is schedule escalation addressed in the schedule estimate?

    Where are assumptions added to support this escalation?

    How is this escalation communicated within the project?

    What are some ways to improve this communication?

11. What requirements associated in developing an estimate exist in your organization for the estimate?

    Is this important?

    Should any changes or improvements be made to what is being done?

12. Has anyone experienced problems with the units of measure being incorrect or not being included with the data?

    Do any areas need improvement?

13. What experience have you had with the actual productivity of the project work being very different from what was identified in the estimate?

    How can this difference be corrected?

14. Have multiple labor rates ever been used for the same craft at the same site?

    How could this problem be fixed?

15. Resource levels and timely availability of personnel, equipment, facilities, and funding must be known and identified in the estimate. How do you address this requirement in the estimate?

    What are some potential problems if this requirement is not properly addressed, and how could it be improved?

    What problems have occurred when the estimate identified the expense of purchasing a new piece of equipment when a comparable piece of equipment already existed and could perform the work?

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Notes / Discussion Points / Lessons Learned: ______________________________

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Section 1.9: Documentation Provided in Cost Estimate/Lessons Learned

16. How do you ensure that the most up-to-date source of prices is used and documented?

    What keeps this problem from occurring?

17. If your estimate identified a piece of equipment already available to do the job, how do you communicate the fact or ensure that it is available when the time comes?

    For the purpose of the estimate, how do you know what plant equipment is available?

    Who identifies which piece will support each element of work?

    Do places for improvement exist for this process?

18. How do you ensure that all close-out or back-up costs are identified/included in the estimate?

    How do you address health and safety costs?

    Are emergency costs factored in?

    What is the best approach to this problem?

19. Cost-and-schedule risk analysis and contingency are very important. How do you address and identify each?

    What could be improved?

    How do you obtain creditable risk analysis data on each?

    Do any past data comparisons exist that could improve this process?

    When do you feel comfortable with the analysis?

20. After an estimate is established, what is used to identify changes?

    Does a change-control document exist to reflect changes and allow quick evaluation of a revised estimate?

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Notes / Discussion Points / Lessons Learned: ______________________________

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Section 1.9: Documentation Provided in Cost Estimate/Lessons Learned

21. What is required to produce "confidence" in the estimate?

    How do you do that?

    What could help improve this process?

22. Who approves the estimate package?

    How are individual sections of the estimate certified?

    Does a system exist to ensure this level of quality?

Notes / Discussion Points / Lessons Learned:

Section 1: Transition Slide

Completed:

✓ **Cost-Estimating Concepts**

Left To Go:

— **Cost-Estimate Preparation**
— **Preparation of a Planning Cost Estimate**
— **Preparation of a Detailed Cost Estimate**
— **Validation of a Cost Estimate**

27

We have reviewed and discussed in Section 1 concepts of cost estimating.

- DOE Cost-Estimating Guidance and Practices
- Project Team
- Baseline Elements
- Life Cycle of Environmental Restoration Projects
- Types of Cost Estimates
- Cost-Estimating Methods and Tools
- Types of Costs
- Cost-Estimate Process (Detailed Estimate)
- Documentation Provided in a Cost Estimate

We will now learn how to apply these concepts in the following section on the development of a planning estimate and a detailed estimate.

Notes / Discussion Points / Lessons Learned: ______________________________